SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY, 1929.

GENERAL PHYSICS.

365. Micrometer for Measuring the Thickness of Varnish Films. *Journ. Sci. Instruments*, 5. *pp.* 323–324, *Oct.*, 1928.

An instrument for the accurate measurement of the mean thickness of the whole of the surface of a film of dry varnish is described and illustrated. It is made by the Cambridge Instrument Co., and consists of two ground-glass plates, between which the film is placed. The plates are placed on a heavy metal base which carries an upright with a horizontal arm above the top plate. A micrometer screw of 1-mm. pitch with a large graduated disc and register has a silver contact, which may be screwed down to touch a gold contact on the top of a brass disc which rests on the upper glass plate. With the aid of a battery and pair of telephones the operator adjusts the micrometer screw until a click is heard. The difference in readings with the varnish film in and out gives the mean thickness. A note on the preparation of such films is appended. E. H. W. B.

366. Simple Arrangement for Stroboscopic Investigations. H. E. Linckh and R. Vieweg. *Zeits. f. Instrumentenk.* 48. *pp.* 416–421, *Sept.*, 1928.

The use of the stroboscopic method for the study of motion phenomena observed over long periods involves the difficulty that the frequency of the "observation method" must always synchronise with that of the observed phenomenon. A convenient electrical arrangement is described which permits the intermittent light from the observed phenomenon to be utilised. L. L. B.

367. Energy Loss of Wheels Rolling in Contact. H. Fromm. *Zeits. f. tech. Phys.* 9. 9. *pp.* 299–311, 1928.

The general relations between energy loss, change of shape of the wheels and slip. Energy loss in consequence of elastic hysteresis. Slip due to (*a*) change of form, (*b*) gliding. Effect of vibration. A. A. D.

368. Measurement of Internal Energy Loss due to Elastic Hysteresis. E. Voigt. *Zeits. f. tech. Phys.* 9. 9. *pp.* 321–337, 1928.

The specimen in the form of a rod is fixed at its upper end to a massive block of metal and at its lower end to a smaller, but appreciable, mass. By means of an alternating-current device (frequency 500) the lower mass and the rod are thrown into forced longitudinal vibration. The vibrations are recorded on a moving photographic film by optical arrangements which are described. The particular object of the experiments is to examine the decay in the amplitude of the vibrations after forcing ceases, the logarithmic decrement being closely related to the internal energy loss. The method of correcting for that part of the energy loss due to air disturbance is indicated, and the final results show the decrement plotted against the amplitude. Iron and steel, copper, brass, glass and porcelain have been examined after various initial treatments (fatigue, temperature, etc.). From the results a dynamic value for Young's modulus may be found. A. A. D.

369. Determination of Stress and Strain during Impact Indentation. J. Ôkubo and M. Hara. *Frank. Inst., J.* 206. *pp.* 471–488, *Oct.*, 1928.

A steel sphere attached to the bob of a heavy pendulum impacts against a block of the material under examination (Fe, Pb, Al, Sn, Zn, Cu). The displacement-time curve of the sphere after the moment of impact is recorded photographically, the arrangement used being described in detail. From such curves the velocity-time curves and acceleration-time curves are found by differentiation. It is concluded: (1) The coefficient of restitution diminishes as the velocity just before impact increases; (2) the time of contact diminishes as the velocity at impact increases; (3) the volume of the indentation at any instant is proportional to the total loss of kinetic energy up to that instant. A. A. D.

370. Application of Tensor Analysis to Physical Problems. F. D. Murnaghan. *Phil. Mag.* 6. *pp.* 779–788, *Nov.*, 1928. *Supplement.*

This paper contains a treatment of the problem of determining the form of the stress equations of elasticity in any system of curvilinear coordinates, orthogonal or not, in the hope that a comparison of the method with that given in Love's *Mathematical Theory of Elasticity*, 3rd edition, pp. 87–89, for the special case of orthogonal curvilinear coordinates will show that the methods of tensor analysis are not only more general, but easier to follow than the method given there. H. H. Ho.

371. Molecular Cohesion. G. A. Tomlinson. *Phil. Mag.* 6. *pp.* 695–712, *Oct.*, 1928.

A method has been devised for the measurement of the force of adhesion between fibres and spheres of either glass or quartz. It is found that the limiting force of adhesion between spheres is proportional to their radius. Further, for quartz fibres the ratio of the force of free adhesion to the force of limiting adhesion is 4·4. These results are applied to the mathematical analysis of two theories of molecular cohesion. If the cohesive force is given by the expression, Force = K/d^n, and if this force is due to the interaction of the electric fields of unsymmetrical surface molecules, then n cannot be less than 4, and is probably equal to 4. If, however, these forces are gravitational in nature, n cannot be less than 6. The author shows that the ratio of the tenacity to the inverse sixth power of the distance of closest approach of the atoms is constant for a series of metals crystallising in the face-centred cubic system. This empirical expression is not opposed to the above inverse fourth power law. F. J. W.

372. Relation between the Viscosity and Yield Point of Lead. W. D. Kusnezow. *Zeits. f. Phys.* 51. 3–4. *pp.* 239–262, 1928.

The coefficient of viscosity for solid bodies depends on the velocity of deformation. In consequence the values for the same material, given by observers using different methods, vary widely. These methods of evaluation of η, however, take no account of the yield point of the material. Actually the deforming force modifies the yield point, and it is the difference between these forces that causes flow. In the present experiments, devoted to rods of lead strained in torsion, an endeavour is made to obtain the yield point under any given conditions of stress. Suitable modifications of the formulæ then yield constant values for η. Confirmatory experiments on a loaded lead beam showed that, by gradual increase in the load, the yield point rose in four months from 0·05 to 0·32 kg./mm.^{2}.

A. A. D.

373. Viscosity of Gases and Vapours. Part I. Air and Bromine. H. Braune, R. Basch and W. Wentzel. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 176–192, *Oct.*, 1928.

An apparatus consisting entirely of quartz is described, by means of which the viscosities of gases and vapours may be determined by the oscillating disc method. The apparatus may be used up to about 600° C., temperatures up to 450° C. being measured with a silver-constantan thermocouple, and above 450° C. with one of platinum-platinum rhodium. The method of determining the vacuum logarithmic decrement is described, and the results of a series of measurements on dry air (from 292·5 to 943·7° abs.) and bromine vapour (292·0–867·0° abs.) are recorded. For air, the straight line obtained by plotting $T^{3/2}/\eta \,.\, 10^{-7}$ against T shows a slight change of direction above 750° abs. On determining the constants of Sutherland's formula by the method of least squares it is found that for T = 290–750° abs., $\eta = \dfrac{150{\cdot}26 \,.\, 10^{-7} \,.\, T^{3/2}}{T + 123{\cdot}6}$, and for $T > 650°$ abs., $\eta = 164{\cdot}4 \,.\, 10^{-7} \,.\, T^{3/2}/(T + 200)$. The values over the lower temperature interval are in good agreement with those of previous investigators. Possible sources of error in the recent work of Williams on the viscosity of air [see Abstract 1193 (1926)] are discussed. His values, with the exception of those at room-temperature, may be brought into agreement with those of the author by a method of re-calculation, in which the mean of nine values over a temperature range of 50° is used as reference value. In the case of bromine, the results below 460° indicate a deviation from Sutherland's formula; above 460° they may be represented by $\eta = 236{\cdot}6 \,.\, 10^{-7} \,.\, T^{3/2}/(T + 532{\cdot}8)$.

L. L. B.

374. Viscosity of Gases and Vapours. Part II. Mercury, Cadmium and Zinc. H. Braune, R. Basch and W. Wentzel. *Zeits. f. phys. Chem.* 137. 5–6. *pp.* 447–457, *Oct.*, 1928.

The paper describes experiments made to test the applicability of Sutherland's formula, $\eta = KT^{1/2}/(1 + c/T)$, to gases other than the inert ones. The apparatus used was that previously described in Part I [see preceding Abstract], and the method of using it for the vapours mentioned is explained. The results are given and plotted, the ordinate being T and the abscissa $T^{3/2}/\eta$, and straight lines are obtained, showing that Sutherland's formula is applicable. The values of the constants were found to be:—

	$K \cdot 10^7$.	C.	Temperature Interval.
Mercury....	612·3	942	490° — 880° K.
Cadmium ..	485·6	1053	790° — 900° K.
Zinc	410·0	876	880° — 950° K.

The thermal conductivity and the atomic diameters are also calculated from the observed values of η. The results are discussed from the point of view of Debye's theory of electrical action between the molecules. T. B.

375. Method of Approximate Integration of a Certain Differential Equation and its Application to the Motion of a Viscous Fluid Round an Oscillating Circular Disc. I. Kobayashi. *Tohoku Univ., Sci. Reports,* 17. *pp.* 1039–1050, *Sept.,* 1928. *In German.*

The mathematical portion is too complicated to abstract, and when the results are applied to experimental observations it is found that agreement is not so good unless one of the correction terms is omitted. W. G. B.

376. Equations of Viscous Motion and the Circulation Theorem. H. Jeffreys. *Cambridge Phil. Soc., Proc.* 24. *pp.* 477–479, *Oct.,* 1928.

The equations of motion of a viscous fluid are derived by the use of tensors, and a new formula for the rate of change of the " circulation " is obtained. This shows that the changes in the circulation round a contour depend only upon the vorticity in its neighbourhood, and explains the equality of the circulation round an aeroplane and the vortex left behind when it starts. W. G. B.

377. Motion of a Rotating Circular Cylinder filled with Viscous Fluid. A. F. Crossley. *Cambridge Phil. Soc., Proc.* 24. *pp.* 480–488, *Oct.,* 1928.

Mathematical. W. G. B.

378. Tidal Waves in Canals having Sinuous Banks. A. C. Banerji and R. S. Varma. *Cambridge Phil. Soc., Proc.* 24. *pp.* 567–577, *Oct.,* 1928.

The effect upon tidal waves of small sinuous variations in the width and depth of a canal is investigated, neglecting cubes and higher powers of the variations. W. G. B.

379. Oseen's Theory for the Approximate Determination of the Flow of a Fluid with Very Small Friction along a Body. J. M. Burgers. *K. Akad. Amsterdam, Proc.* 31. 4–5. *pp.* 433–453, 1928.

The approximation consists in supposing that vorticity is only present in the wake of the body, between the two extreme parallels to the stream which touch it. A distribution of vorticity in this region, which enables the velocity on the rear surface of the body to be annulled, is then found. Details are given for two-dimensional streaming past a cylinder and a flat plate, and the fluid resistance is calculated. W. G. B.

380. Steady Motion and Stability of a Helical Vortex. H. Levy and A. G. Forsdyke. *Roy. Soc., Proc.* 120. *pp.* 670–690, *Oct.* 1, 1928.

The right helical vortex is assumed of uniform strength and an examination is made of the conditions under which such a motion will be stable. The nature of the disturbances to the filament is examined, the vibrational equations are established, and the conditions for stability are found. The method is given in detail and the results are shown for five different cases. It is found that for $\tan\alpha > 0\cdot3$ the helical vortex is stable in form, while for $\tan\alpha < 0\cdot3$ it is unstable. The rotational speed of the system about its central axis undergoes a reversal of sign at $\tan\alpha = 0\cdot3$ approximately, indicating that the helical vortex of minimum pitch, which, if created, would just maintain its form unimpaired, would also move through the fluid steadily without rotation. Two principal factors determine the forward motion and the rotation of the system at any point on the filament, these being adjacent elements of the same coil and the elements of neighbouring coils of the helix. [See also Abstract 14 (1928).] R. S. R.

381. Flow in a Pipe of Rectangular Cross-Section. R. J. Cornish. *Roy. Soc., Proc.* 120. *pp.* 691–700, *Oct.* 1, 1928.

The flow in a pipe 1·178 cm. by 0·404 cm. was studied experimentally. For stream-line flow the results agreed very well with the theoretical formula; and the turbulent flow agrees with that obtained by others for circular brass pipes. W. G. B.

382. Mechanical Method for Solving Problems of Flow in Compressible Fluids. G. I. Taylor and C. F. Sharman. *Roy. Soc., Proc.* 121. *pp.* 194–217, *Nov.* 1, 1928.

In this paper a method is described by which it is possible, without very great labour, to find the flow of a compressible fluid past an obstacle of any shape provided that irrotational motion is possible. The first application of the method has been to Rayleigh's case of the circular cylinder, when successive approximations have been obtained which are practically identical with those which would result from successive applications of Rayleigh's mathematical method. One of the most important results is the discovery that the failure of convergence occurs not when the speed of the main body of the stream reaches that of sound, but at some lower speed. In the case of a circular cylinder convergence fails when the maximum velocity in the field reaches the speed of sound in the air at that point. This first occurs when the speed of the stream is between 0·4 and 0·5 of that of sound; at a speed of 0·5 it appears that no continuous irrotational motion is possible past a circular cylinder. The method is applicable to cylindrical bodies of any cross-section and even to aerofoils which carry a circulation with them. [See also Abstract 1465 (1928).] H. H. Ho.

383. Aerofoils of Small Thickness. H. Jeffreys. *Roy. Soc., Proc.* 121. *pp.* 22–28, *Nov.* 1, 1928.

384. Relation between Kinematic Pairs and Links in a Mechanism. W. J. Walker. *Phil. Mag.* 6. *pp.* 631–632, *Oct.*, 1928.

The formula usually given for the relation between the number of pairs and the number of links in a mechanism is $L = 2P - 4$, but this is based on a somewhat arbitrary elimination of certain pairs. It is shown that, using a simple convention, $L = (2P + 4)/3$; L is the number of links and P the number of pairs in both these formulæ. H. N. A.

385. Best Correction Factors for Harmonic Coefficients. A. Eagle. *Phil. Mag.* 6. *pp.* 824–828, *Nov.*, 1928.

Referring to his paper, "Relation between the Fourier Constants of a Periodic Function and the Coefficients determined by Harmonic Analysis" [see Abstract 1144 (1928)], the author justifies the use of the correction factors therein suggested. He points out that the table of correction factors in the paper are all founded on reasonable assumptions about the amplitude of the higher harmonics. A graphical method is described which can in many cases be used in place of the tables of corrections, and it is emphasised that the limited accuracy of harmonic analysis must not be overlooked. T. B.

386. Enantiotropy and Monotropy. Part II. N. Nagasako. *Chem. Soc. Japan, Bull.* 3. *pp.* 209–217, *Sept.*, 1928. *In English.*

This paper supplements a previous one [see Abstract 2252 (1928)], in which the typical thermodynamic relations for enantiotropy and monotropy were discussed in general. The affinity and heat of transition from diamond to graphite and from white to red phosphorus have been evaluated on the basis of the Nernst theorem and found to be monotropic under atmospheric pressure. The former case will probably, however, be enantiotropic under pressure, whereas the latter will remain monotropic even under high pressure. An approximation formula for the estimation of the affinity of transition has been derived by means of which the dimorphisms of ethyl ether, iodine monochloride, benzophenone, phthalide, bromo-nitrobenzene, acetanide, monochloroacetic acid, nitro-*p*-toluide and erythrite have been estimated to be monotropic. H. H. Ho.

387. Structure of Surface Films. Part XII. Cholesterol. N. K Adam and G. Jessop. *Roy. Soc., Proc.* 120. *pp.* 473–482, *Sept.* 1, 1928.

Leathes showed in 1923 that cholesterol, when mixed with certain fatty acids in monomolecular films on water or on diluted hydrochloric acid, caused a diminution of the area occupied by the fatty acid. These acids alone gave expanded films. The authors conclude that there is no special attraction between the cholesterol molecules, consisting according to Windaus of several benzene rings and a side chain, and the fatty acids, but that the large cholesterol molecules have sufficient inertia mechanically to obstruct the tilting motions of the fatty acid molecules. These motions [see Abstract 1139 (1928)] are the cause of the expanded state of surface films. The cholesterol and some of its simple derivatives (formate and acetate) form condensed films of area 39 sq. Å. with their closely packed ring systems strongly adhering even at 80° C. Mixed with substances which form expanded liquid films—myristic acid, palmitic nitrile, etc., in proportions of 1 cholesterol to 2 or more (up to 8) other substances—the expanded films are reduced in area to the state of condensed films, provided the temperature is not too high. If that condensation were due to attraction between the different molecules, the freezing-point depression of the molecules should be abnormal, but that is not observed. Moreover, the condensing effect of cholesterol can be imitated by other large molecules, such as tripalmitin. H. B.

388. Reflection of Hydrogen Atoms from Crystals. T. H. Johnson. *Frank. Inst., J.* 206. *pp.* 301–315, *Sept.*, 1928.

An experimental study was made of the reflection of hydrogen atoms from certain crystals, including cleavage surfaces of calcite, sylvite and rock-salt and natural crystal faces of quartz. All the crystals investigated reflect the hydrogen atoms diffusely if the temperature of the surface is high enough. The intensity of the diffuse reflection depends markedly on the temperature of the crystal and also on the actual crystal used. Sylvite must be at a very much higher temperature than rock-salt to reflect diffusely with the same intensity, whereas quartz and calcite must be at a

temperature somewhere between these two. In addition to the diffuse reflection rock-salt also reflects specularly. Near grazing incidence as much as 10% of the incident atoms are reflected regularly if the temperature of the crystal is just under its sublimation point, *i.e.*, about 400° C. The results obtained are discussed from the standpoint of wave mechanics.
A. W.

389. Liquid Crystals. L. S. Ornstein. *Phys. Zeits.* 29. *pp.* 668–669, *Sept.* 15, 1928.

Referring to Errera's paper on the electric moment of paraoxyanisol [see Abstract 2827 (1928)], the author points out that he had [see Abstract 2388 (1924)] not really ascribed a rod structure to the molecules. That the liquid crystalline phase appeared turbid in thick layers was a macroscopic phenomenon, due to microscopic double refraction. An aggregate of regions of anisotropic dielectric constant (d.c.) would show a mean d.c. when in random orientation. A magnetic field would lead to some orientation. If that were so, Errera objected, frequency should influence the d.c.; but the orientation was too slow a process to affect the d.c. There were, however, thermal effects. When a thermocouple was soldered to a silver plate and the magnetic field was turned on, heat was liberated (and absorbed) on closing (breaking) the circuit, but only when the field was at right angles to the plate, because then the orienting effect of the field was supporting that of the wall. Further, the polarisation phenomena in a liquid crystalline substance changed with variations in the field strength (A. van Wyk, unpublished). Molecules near the wall tended to orient themselves in parallel lines, but the cause of the formation of swarms (or regions) of parallelly oriented molecules in the liquid was obscure.
H. B.

390. Crystal Structure and Modes of Chemical Combination. V. M. Goldschmidt. *Zeits. f. Elektrochem.* 34. *pp.* 453–463; *Disc.*, 480–483, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

Discusses the distances between the atoms in crystals, and shows that in certain groups of crystal structures the distances can be regarded, to a close approximation, as the sums of the radii of spherical particles closely packed; such groups of structure are spoken of as commensurable, while other groups, in which the additive law does not hold, are incommensurable. The relations between the distances between the atoms, the nature of the lattices, the modes of chemical combinations involved, the valencies of the constituents of the different compounds and the hardness as tested by the scratching method are considered. It is shown that in ionic lattices, in non-ionic lattices of heteropolar compounds and in diamond and zincblende wurtzite lattices the binding force between the particles increases with increase in the valency involved, and diminishes with increase in the distance between the particles. This diminution takes place according to a lower power of the distance in the case of typical ionic lattices than in the zincblende type. Molecular lattices seem to have the molecules connected by weak forces of the same type as the van der Waals' forces of gases and liquids. Solidified rare gases appear to be held together by these forces. Work on refraction and dispersion in crystals may be expected to give information as to the methods of binding involved. **J. Kasarnowsky, H. G. Grimm, W.**

Kossel, K. Fajans, W. Biltz, B. Gudden, C. Tubandt and **G. Tamman** took part in the *Discussion.* H. N. A.

391. Electrical Conductivity as a Criterion of the Mode of Combination. G. v. Hevesy. *Zeits. f. Elektrochem.* **34.** *pp.* 463–472; *Disc.*, 480–483, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

The passage from one mode of binding to another can be followed by means of kinetic considerations, by investigating the possibility of change of place by the components of the crystal lattice, and also the ease with which the atoms leave their molecular union. In the crystalline state certain extreme types—the strictly heteropolar compounds, metals (ideal metallic mixture crystals) and compound molecules—are distinguished by extremely small velocities of change of place in the lattice components; on the other hand, in the case of types which lie in the region between these extreme types, there are in some cases very considerable velocities for the changes of place. In strictly heteropolar silver compounds on one side, and in metallic silver on the other, these velocities are very small, but they have extraordinarily large values in αAgI and αAgS, much larger than in $AgNO_3$, and considerably larger than in AgCl and AgBr; αAgI comes just before the ionic lattice changes into structures with hexagonal closest spherical packing, such as Ag_3Sb and Ag_4Sn. This region of greatest loosening of the lattice and greatest velocity in the changes of place of Ag^+ is the same as that where polymorphic transformations take place, since both phenomena are due to a specially favourable relation between the sizes of the ions and a very easily polarised anion. The curve of distortion of the silver ion as the atomic weight of its partner atom is increased shows a steeply rising branch, followed by a still steeper falling branch. The deformation of the Cl ion in passing from NaCl through $CdCl_2$, $PbCl_2$, $SbCl_3$, $AsCl_3$, $NbCl_5$ to Cl_2 is also dealt with, together with the conductivity of a number of salts near the melting point and of their melts. H. N. A.

392. Electrical Conductivity and Diffusion in Crystalline Compounds. A. Smekal. *Zeits. f. Elektrochem.* **34.** *pp.* 472–480; *Disc.*, 480–488, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

Analyses the temperature conductivity curve for monocrystals in which the conductivity is ionic, and finds that there are two different kinds of ions concerned. At low temperatures the author considers that the conduction takes place through portions of the crystal in which the lattice is imperfect; the "loosened" portions seem to be regarded as very minute hollows in the crystal, the ions on the surface of which are not part of the crystal lattice and at ordinary temperatures move under the influence of an applied e.m.f., while the lattice ions are unable to do so. The increase in conductivity found by v. Hevesy in passing from monocrystals to polycrystals is due entirely to the former class of ions, the "loosened" ions. The following formula gives the value of the conductivity at different temperatures: $\kappa = A_{I}e^{-E_I/T} + A_{II}e^{-E_I/T_I}$, the first term giving the effect of the loosened ions and the second that of the lattice ions. The ratio A_{II}/A_{I} is of the order of 10^6, and appears to be the same as that between the number of the lattice ions and that of the loosened ions. The velocities of movements of the ions separated from the ideally formed portions of the lattice and of the "loosened" ions are practically identical in an electric field, which seems to indicate that a lattice ion, when split off by thermal movements, has only to move through a few hundred lattice spaces before it comes to a loosened portion of the crystal, through which it can travel to the electrode with the velocity of a "loosened" ion. Electronic conduction takes place through the perfect lattice and not through the "loosened" portions of a crystal. H. N. A.

393. Crystal Structure of Compressed Magnesium and Aluminium Plates. S. Tsuboi. *Kyoto Coll. Sci., Mem.* 11. *pp.* 375–382, *Sept.*, 1928. *In English.*

By the use of X-ray methods it is found that when a circular plate of magnesium is compressed the microcrystals tend to set the hexagonal axis in the direction of compression. The fibrous arrangement of the microcrystals obtained by compressing a circular plate of aluminium takes the [110] axis of the crystal as the axis of the fibre in the direction of compression, and corresponds to that of the complete rotation of microcrystals. For a compressed long elliptical aluminium plate, near the minor axis of the ellipse, where the metal flows in the direction of this axis, the fibre axis becomes the [112] axis of the specimen parallel to the minor axis. At the end of the major axis of the ellipse the structure is the same as for the compressed circular plate. Thus the fibrous structure depends on both the direction of compression and on the direction of flow of the metal. W. H. Ge.

394. Röntgen-Ray Studies of the Configuration of the C — C Linking. A. Reis and W. Schneider. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 126–130, *Oct.*, 1928.

Having explained [*Ber. Deut. Chem. Ges.* 59. *pp.* 1543 and 1553, 1926] the method of the X-ray studies of stereochemistry problems and the relations between molecular and crystal structure with special regard to molecules symmetrically grouped about a central C — C link, the authors summarise the results of further investigations by themselves and others in tabular form. The paper concerns particularly organic compounds in crystals and solutions with a C — C or C = C linking, but the conclusions, mainly in accord with Weissenberg's theory [see Abstract 543 (1927)], apply also to inorganic compounds. Cutting of a C — C link by a mirror plane has not been observed, nor have symmetry elements parallel to that link, except in the case of ethane. H. B.

395. Slip in a Crystal and Rupture in a Solid due to Shear. A. T. Starr. *Cambridge Phil. Soc., Proc.* 24. *pp.* 489–500, *Oct.*, 1928.

The stress in the neighbourhood of an elliptical crack in a solid in a state of shear is worked out in two dimensions. The distortion and strain energy are also calculated, and the tearing shear is determined upon certain plausible assumptions. W. G. B.

396. Absorption Lines of Chrome Alums. H. Sauer. *Ann. d. Physik*, 87. 2. *pp.* 197–237, *Oct.* 5, 1928.

A photometric study of the absorption lines of crystals of various chrome alums at − 190°, − 78° and 18° C. W. H. Ge.

397. Lattice Constants of Mixed Crystals of KCl and KBr. Frida Oberlies. *Ann. d. Physik*, 87. 2. *pp.* 238–258, *Oct.* 5, 1928.

A study by X-ray methods of the change in lattice constant with composition of mixed crystals of KCl and KBr. For KCl $d = 3 \cdot 1362$ Å. and for KBr $d = 3 \cdot 2952$ Å. For the mixed crystals the additive law of Vegard holds good. W. H. Ge.

398. Polarisation of Ions in a Crystal Lattice. A. E. van Arkel. *Zeits. f. Phys.* 50. 9–10. *pp.* 648–656, 1928.

The polarisation energy of an ion in a crystal lattice is calculated on the assumption that it is symmetrically polarised. It is shown that the polarisation energy of binary compounds is a minimum in the CsCl lattice, increasing with decreasing coordination number. Thus the transition from the CsCl to the NaCl type and then to the zinc-blende type is understandable as due to increasing polarisability. In the alkaline halides one finds the CsCl type in compounds with small polarisation energy. J. E.

399. Crystal Structure and Linear Thermal Expansion Coefficient of Tungsten Carbides. K. Becker. *Zeits. f. Phys.* 51. 7–8. *pp.* 481–489, 1928.

Data are given from Röntgenographic determinations for the crystal structure and linear thermal expansion coefficient of the system tungsten-carbon. It is found that a–W_2C is very anisotropic and that the thermal expansion in the direction of the C-axis is ten times as great as along the a-axis. With WC the difference in the two directions is much less marked and only amounts to 50 %. H. H. Ho.

400. Recrystallisation Phenomena in Aluminium. A. E. van Arkel and M. G. van Bruggen. *Zeits. f. Phys.* 51. 7–8. *pp.* 520–533, 1928.

A continuation of previous work [see Abstract 2213 (1927)]. With strong deformations the recrystallisation caused by the internal strains gives such small crystals that another crystallisation can occur. This second process depends not only upon the working, as does the first, but also on the initial state of the metal. Pure and commercial aluminium differ only in the magnitude of the effect. They differ in that the surface recrystallisation is much quicker with the pure, and therefore not so easy to distinguish from the "working" recrystallisation. The previously given rule for weakening is not so widely true for pure aluminium. J. E.

401. Recrystallisation in Zinc. A. E. van Arkel and J. J. A. Ploos van Amstel. *Zeits. f. Phys.* 51. 7–8. *pp.* 534–544, 1928.

Researches on the "working" recrystallisation of zinc have shown that its course is exactly the same as with aluminium [see Abstract 2213 (1927)] except at room-temperature. J. E.

402. Wave-Mechanics Calculation of Lattice Forces and Determination of the Ionic Magnitudes, Compressibilities and Lattice Energies of Simple Salts. H. Brück. *Zeits. f. Phys.* 51. 9–10. *pp.* 707–727, 1928.

In this paper the quantum theoretical calculation of the Born-Landé repulsion forces is applied to solid bodies after certain extensions to the Unsold theory. Sections deal with the electronic affinity of hydrogen, ionic radii, compressibilities, the lattice and dissociation energy of the alkali halides, deformation energies and the hydrogen halides, based on the determination of the compressibilities of the simplest diatomic salts. Excellent agreement is found between the calculated and the experimental results. H. H. Ho.

403. Bauschinger Effect. H. Shoji. *Zeits. f. Phys.* 51. 9–10, *pp.* 728–729, 1928.

This paper supplements previous work by Sachs and the author [see Abstract 817 (1928)] on stress-strain measurements with crystals of brass (Bauschinger effect). The data are now explained on the Boltzmann theory of elastic after-effect, assuming the validity of the superposition principle. H. H. Ho.

404. Crystal Structure of Calcium. C. D. Niven. *Phil. Mag.* 6. *pp.* 665–666, *Oct.*, 1928.

Crystals of calcium were obtained by distillation of the metal, and from examination of these it was found that calcium has a cubic structure. Measurement of a crystal by the goniometer showed that it was a rhombic dodecahedron. J. J. S.

405. Crystal Structure of Cu_9Al_4. A. J. Bradley. *Phil. Mag.* 6. *pp.* 878–888, *Nov.*, 1928. *Supplement.*

Powder photogrammes of δ copper-aluminium containing 16–19 % of aluminium show that this alloy has a cubic structure with 52 atoms per unit cell, 36 of these being copper atoms, and the alloy, therefore, corresponding to the formula Cu_9Al_4. The structure is essentially of the CsCl type, each lattice point being replaced by a cluster of 26 atoms, with tetrahedral symmetry. The cluster around the centre of the unit cell contains a different number of aluminium atoms from that around the corners of the unit cell. The coordinates of the atoms are not appreciably different from those in the alloy Cu_5Zn_8. A. W.

406. Normal State of Helium. J. C. Slater. *Phys. Rev.* 32. *pp.* 349–360, *Sept.*, 1928.

An approximate wave function is calculated for normal helium, using a method which is practically the same as that described in a previous paper [see Abstract 1500 (1928)]. Theoretical functions are determined for large r and small r, and interpolations are made between them. The charge density computed agrees with that found by Hartree. The diamagnetism of normal helium, as calculated from this wave function, agrees with observation within the experimental error. The repulsive forces between two helium atoms are calculated, using Heitler and London's method, and the van der Waals' attractive forces are roughly estimated from Wang's results with hydrogen. The potential curve thus found gives a "molecular diameter" in agreement with experiment; the minimum of the curve leads to an approximately correct density and boiling point for liquid helium. The agreement with the values of the "radius" of the helium atom deduced from the potential curve and that determined from kinetic theory is satisfactory. The various distances which are quoted by Jeans seem to represent the distances of closest approach of average atoms in the temperature range usually used; this is the only reasonable meaning of the term diameter for such a structure. H. N. A.

407. Density of Boric-Oxide Glass and Atomic Weight of Boron. A. Cousen and W. E. S. Turner. *Chem. Soc., J. pp.* 2654–2657, *Oct.*, 1928.

Briscoe, Robinson and Stephenson (*ibid.*, p. 70, 1926), examining boric-oxide glasses from different sources, found densities of B_2O_3 ranging from 1·79711 to 1·79404; the corresponding atomic weights of boron would range from 10·847 to 10·788. The authors determined the density of boric-acid glass between 18° and 25°, and found 1·844 by the specific gravity bottle method and 1·8439 by the flotation method. Studying the influences of impurities, method, traces of moisture, temperature and rate of annealing, they conclude that this last source of error, inadequate annealing, would account for the discrepancies, and that density determinations of such glasses from six different terrestrial sources cannot be accepted as evidence of any variation of the atomic weight of boron with the source of the mineral. H. B.

408. Quantum Mechanics and Chemical Linkage. F. Hund. *Zeits. f. Elektrochem.* 34. *pp.* 437–442; *Disc.*, 442–445, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

The quantum mechanics of Heisinger and Schrödinger should admit of deciding whether the empirical conceptions of ionic and atomic molecules and valency can exactly be defined or had better be discarded. The author discusses these problems with special regard to the connection between molecular structure and atomic spectra and to the consequences of his researches on the symmetry characteristics of terms [see Abstracts 2810 and 2826 (1927)]. The expression ionic molecule had been used to denote that the grouping of the electrons in a molecule is approximately the same as when two ions are brought close to one another, which may be possible to a certain extent in NaCl vapour, but is no longer possible in HCl. The ionic conditions of a molecule may be such as would, in the separations of the nuclei in the corresponding two-centre problem, pass into ionic terms, whilst atomic conditions would pass into atomic terms; but the distinction is only apparently sharp. When two nuclei approach one another, the energy may first diminish and then increase. A valency is saturated when in the union of atoms to a molecule the number of the symmetrically-coupled pairs of electrons is increased. This is in accord with London [see Abstract 842 (1928)], and saturation would be analogous to the completion of an electron shell in the atom. The question, which molecules do exist, and how firmly they are linked, is an energy problem. The further question, as to the appearance of a term scheme and of the spectrum of the molecule, is qualitatively answered by the solution of the two-centre problem with the aid of our knowledge of atomic terms and by estimates of the energy changes in the transition of the molecule. H. B.

409. Coordinative Bonds and Electronic Theory of Valency. N. V. Sidgwick. *Zeits. f. Elektrochem.* 34. *pp.* 445–450; *Disc.*, 453, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

There are two kinds of chemical bonds: electrovalency, due to electrostatic attraction between two atoms of opposite charges, and covalency, due to the sharing of electrons by two atoms. It is further assumed that two electrons are shared in every covalent linkage (except in some unstable hydrogen compounds such as H_2^+, B_2H_6). This theory is extended to comprise the coordinated compounds of Werner by assuming that the two electrons may come from the same of two atoms, A and B, so that a dipole moment is produced; this covalency is indicated by an arrow, A → B, A being the donor, B the acceptor, and is also called a half-polar link. The assumption explains why the linkage need not be ionised in complexes, why the numbers of 6 and 4 (also 8) covalencies predominate, and why the electrovalency changes when a univalent atom is replaced by a molecule like ammonia. There may be intermediate links between the electrovalent and the covalent. Reference is made to the author's address at the Chemical Section, British Association, 1927, on the "Electronic Theory of Valency," and to his book of this title. H. B.

410. Electric Moments of Molecules and Intermolecular Forces. P. Debye. *Zeits. f. Elektrochem.* 34. *pp.* 450–452; *Disc.*, 453, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

The molecular polarisation P in a field of unit intensity can be calculated from the dielectric constant, the molecular weight and the density, but only for gases and for solutions of polar molecules in non-polar solvents. By polar molecules the author understands all molecules which have a dipole moment, no matter whether their dissociation products are electrically charged or not. P is the sum of two effects, $P_0 + P_1$, P_0 due to a deformation of the electric equilibrium in a molecule, and P_1 to the orientation of the molecule as a whole. The two P can be separated by two methods: (1) By observations at different temperatures, since P_0 is independent of temperature, while P_1 varies inversely with temperature; (2) by the determination of the molecular refraction. Single atoms and molecules of two equal atoms are in general not polar; molecules of two unequal atoms are polar; three-atomic molecules, such as H_2O, SO_2, are polar, CO_2 is not; the three valencies of the atoms of N, P, As do not lie in the same plane; methane derivatives become polar when the four substituents are not all equal; benzene di-substitutes are polar unless the two equal substituents are in the para-position. The measurements further admit of separating the substituents into positive and negative groups. Similar considerations apply to intermolecular forces. There will be mutual orientation and always deformation, leading to attraction, and there are again the differences in the temperature influences. The deformation accounts for the residual van der Waals' attraction at high temperature, while the strong fields close to polar molecules explain the strong association of liquids. H. B.

411. Dipole Moment and Constitution. J. Errera. *Phys. Zeits.* 29. *pp.* 689–690, *Oct.* 1, 1928.

In the case of the dihalides of ethylene and of benzene [see Abstract 2762 (1926)] the permanent dipole theory of Debye admits of deducing the position of the atoms in the molecule when the signs of the electric charges of the atoms are known. In the chlor-iodo-ethylenes, ClHC = CHI, the converse problem arises, the positions of the atoms having been determined by van der Waals and Henne. In some derivatives of this compound iodine appears to be trivalent. If the iodine be assumed to be positive, relative to the chlorine, the trans-derivative should have twice the dipole moment of the cis-derivative; this is found to be so approximately. H. B.

412. Homopolar Union in Excited Hydrogen Molecules. E. A. Hylleraas. *Zeits. f. Phys.* 50. 1–2. *pp.* 150–158, 1928.

The reciprocal action between two hydrogen atoms [see Abstract 3046 (1927)] has been calculated for the case when one is in the normal and the other in the excited state. Four solutions are afforded of which two exhibit elastic reflection and two lead to molecular formation. The latter pair are symmetrical as regards the two nuclei, although the electrons are symmetrical in one and not so in the other, corresponding to a para- and ortho-term of the hydrogen molecules. The course of the curves shows a diminution of the work of dissociation and an increase in the moment of inertia with respect to the normal state. H. H. Ho.

413. Covalency, the Paramagnetism of Oxygen and Stereochemistry. H. F. Biggs. *Phil. Mag.* 6. *pp.* 659–664, *Oct.*, 1928.

London's theory of covalency [see Abstract 842 (1928)] is first discussed, *viz.*, that two atoms will form a covalent link when each possesses an unpaired electron if these electrons are in corresponding orbits but spinning opposite ways. The " correspondence " of the orbits includes angular momentum and orientation, but perhaps not radial motion. Further, in any atom in a group of orbits with the same azimuthal quantum number the unpaired electrons all spin the same way. Application is now made to the oxygen, water, nitrogen and carbon atoms and molecules respectively, and the constitution of benzene is discussed, whence it appears that the aromatic properties, hexagonal angles and apparent trivalency of carbon are associated as shown by a consideration of furan and thiophene. London's hypothesis is also shown to be supported by some facts of catalysis, and a partial interpretation is given of the effect of hydrogen in diminishing the paramagnetism of palladium. H. H. Ho.

414. Collisions of the Second Kind between Molecules. The Excitation of the Lyman Bands and the Noncombination of the Symmetrical and the Antisymmetrical Term Systems in the Hydrogen Molecule. H. Beutler. *Zeits. f. Phys.* 50. 9–10. *pp.* 581–599, 1928.

According to wave mechanics it is necessary to assume the existence of two kinds of hydrogen molecules, which are symmetrical or antisymmetrical respectively in their nuclear functions, one form not changing into the other. The author considers the selective excitation of the Lyman bands in a mixture of argon and hydrogen, and after rejecting various suggestions as to its origin, shows that it can only be explained by means of the principle of resonance, with collisions of the second kind, if the impossibility of combination between the symmetrical and antisymmetrical terms is maintained. Passages from one of these sets of terms to the other are not observed. A study of the specific heat of hydrogen, using the moment of inertia calculated by T. Hori, shows that the theoretical specific heats can only agree with the values found by Eucken, by Scheel and Heuse and by Brinkworth if even in several hours, with 10^{10} collisions of every molecule per second, no marked change takes place from H_2 symmetrical to H_2 antisymmetrical. H. N. A.

415. Isotopes. A. Campetti. *N. Cimento*, (*Rivista*), 5. *pp.* 133–141, *July*, 1928.

A useful and comprehensive *résumé* of recent work on isotopes. A. D.

416. Separation of Isotopes and a Further Separation of Mercury by Evaporative Diffusion. W. D. Harkins and B. Mortimer. *Phil. Mag.* 6. *pp.* 601–631, *Oct.*, 1928.

Reviews previous work on the separation of isotopes, and discusses the possibilities of large separations. The apparatus used was that of Harkins and Mulliken, modified by using a ground joint between flask and condenser, so that the time taken in replacing the filter-paper membrane was greatly reduced. The fractionation was carried out in a very systematic manner, full details of which are given; in the final result 101·96 gm. of mercury 0·0962 unit of atomic weight heavier than ordinary mercury, a set of 23 fractions each 0·004 unit heavier progressively than ordinary mercury, 108·76 gm. of mercury 0·0931 unit lighter than ordinary mercury, and 23 fractions each progressively 0·004 unit lighter than ordinary mercury were obtained. The greatest difference in atomic weight obtained was thus 0·189 unit. The lighted and heaviest fractions have been examined spectroscopically by F. A. Jenkins; no differences in their spectra have been detected, though a shift in the direction of higher frequency was found for the heavy fraction in the case of chlorine; the *relative* difference in the atomic weights of the two specimens of chlorine was, however, about three times that for the mercury. Other physical data are being determined for the two specimens of mercury.

H. N. A.

417. Distribution of Electrons in a Metal. J. E. Lennard-Jones and H. J. Woods. *Roy. Soc., Proc.* 120. *pp.* 727–735, *Oct.* 1, 1928.

Uses the new statistics of Fermi and Dirac in a manner similar to that employed by Thomas, and independently by Fermi, to determine the distribution of electrons in heavy atoms. The object of the authors is to regard the metal as a whole and to find the average distribution of the electrons. If a simple cubic lattice array is considered for the nuclei, V, the potential field, is triply periodic, and is uniquely determined when it has been evaluated within an elementary cube surrounding one nucleus. The problem, however, has to be modified, so as to give a kind of two-dimensional metal, before a mathematical solution can be obtained; the nuclei are replaced by a series of parallel line charges, arranged so as to intersect a plane perpendicular to them in a square array, and it becomes possible to plot the equipotential lines about the linear " nuclei." Some of these lines near the nuclei are approximate circles, but at a greater distance they are gradually deformed until a critical curve is reached, beyond which closed equipotential lines pass round points which are equidistant from four nuclei. In these spaces the electrons may be regarded as " shared " between the four neighbouring neclei; they form a lattice array which interpenetrates that of the nuclei. There is a continual interchange of electrons between the various systems. If an electric field were applied to the system, an electric current would flow without resistance, as in the static model proposed by Lindemann.

H. N. A.

418. Self-Consistent Field and Structure of Atoms. J. C. Slater. *Phys. Rev.* 32. *pp.* 339–348, *Sept.*, 1928.

The method proposed by Hartree [see Abstract 1170 (1928)] for the solution of problems in atomic structure is examined as to its accuracy as a method of solving Schrödinger's equation. A wave function is set up at once from his method, and the matrix of the energy computed with respect to it. The non-diagonal terms are shown to be small, indicating that the function is a good approximation to a real solution. The energy levels are found by perturbation theory from this matrix, and are compared with the term values as found by Hartree. His values should be corrected for three reasons: he has neglected the fact that electron distributions are not really spherical; he has not considered the resonant interactions between electrons; and he has made an approximation which amounts to neglecting the polarisation energy. The sizes of these corrections are estimated, and they are found to be of the order of the errors actually present in the numerical cases he has worked out. AUTHOR.

419. Transitions as dealt with in Undulatory Mechanics. L. Goldstein. *Comptes Rendus*, 187. *pp.* 715–717, *Oct.* 22, 1928.

If the symbolic relation $\mathbf{11}m\mathbf{11} \rightleftharpoons \mathbf{11}n\mathbf{11}$ represents all the phenomena possible within an assembly of partial systems, then continuous transition in the sense of one to another may be described by an equation of the Schrödinger type, $H_p\psi(x, t) = ih\partial\psi/\partial t$, where H_p represents the operator involved. The present mathematical paper discusses the application of this equation to atomic systems. H. H. Ho.

420. Characteristic Functions of the Spherical Top in Quantum Mechanics. F. Hund. *Zeits. f. Phys.* 51. 1–2. *pp.* 1–5, 1928.

Refers to the investigation of the rotation terms of a molecule of the type of CH_4 (tetrahedral symmetry) by W. Elert (see following Abstract). It was necessary to study the relations between the eigen functions of a top with three equal moments of inertia (a spherical top) which is equivalent to a rigid structure of the CH_4 type. If the eigen functions are written as $u(\vartheta\psi\phi)$, in terms of the Euler angles, it can easily be seen how they alter with the twofold rotations; this method was employed by Reiche and Rademacher, but it is very inconvenient in considering threefold rotations, and the author shows that a very symmetrical representation of the eigen functions can be obtained by employing as variables the quaternian elements which have already been used in classical mechanics. The eigen functions correspond to the whole of the rational solutions of even degree of the four-dimensional potential equation $\Delta V = 0$. H. N. A.

421. Vibrational and Rotational Spectrum of a Molecule of the Type CH_4. W. Elert. *Zeits. f. Phys.* 51. 1–2. *pp.* 6–33, 1928.

Hund has considered generally the term system of molecules with more than two nuclei, and has dealt with the case of NH_3 [see Abstract 2810 (1927)]. The author deals with the CH_4 type, considering the effects of vibrations in the first paragraph and those of rotations in the second. The object of the paper is to supply experimental investigators with additional material for elucidating the question of nuclear spin and the existence of symmetry characters. The spectrum is worked out for the most important cases, and an estimate is made of the heat of rotation of methane. In solving the problem of the rotational spectrum use is made of the method of dealing with the eigen functions of the spherical top by means of quaternion elements in a four-dimensional problem, as described by F. Hund [see preceding Abstract]. H. N. A.

422. Vibrating Continua with Arbitrarily Distributed Small Damping. M. J. O. Strutt. *Ann. d. Physik,* 87. 2. *pp.* 145–152, *Oct.* 5, 1928.

A method of perturbation calculation is worked out up to the second order for treating the influence of small damping on the vibrations of continua. This, unlike the Schrödinger-Dirac method of calculation, is founded on the theory of quadratic forms in a way quite similar to Rayleigh's treatment of systems with a finite number of degrees of freedom. The method also makes it possible to take into account perturbations of the boundary conditions. By suitably distributing the damping in spaces or along the walls it becomes possible to damp an arbitrarily selected number of characteristic vibrations more strongly than all others. In systems with several characteristic values the damping, to a first approximation, gives rise to a splitting up of such a characteristic value into several, with the same frequency of vibration but with different damping. Examples from electrodynamics and acoustics are dealt with.

H. N. A.

423. Wave Theory of the Electron. J. M. Whittaker. *Cambridge Phil. Soc., Proc.* 24. *pp.* 501–505, *Oct.*, 1928.

A form of the Dirac wave theory is given in which the electron wave is specified by a six-vector instead of by a matrix of the fourth order. The theory gives the right results for the hydrogen atom and for the free electron. The tensor form of the wave equations is given.

W. S. S.

424. Dynamics of an Electron. D. Meksyn. *Phil. Mag.* 6. *pp.* 977–991, *Nov.*, 1928.

Space and time in physics, the fundamental form of dynamical space, and the two-electron problem are discussed. The general equation of motion for several (n) material points or electrons is a geodesic line in $4n$ dimensional space. The electron is shown to possess 4 degrees of freedom, the fourth being in the direction of time, or, better, is the kinetic energy.

J. S. G. T.

425. Riemannian Manifolds and Non-Euclidean Space Forms. Parts I and II. P. Koebe. *Preuss. Akad. Wiss. Berlin, Ber.* 23. *pp.* 345–442, 1928.

General space forms and fundamental groups—and more especially hyperbolical, cyclical hyperbolic, spherical, elliptical and parabolic groups—are discussed in considerable detail. [See also Abstract 1511 (1928)].

J. S. G. T.

426. Structure of Time. G. I. Pokrowski. *Zeits. f. Phys.* 51. 9–10. *pp.* 737–739, 1928.

The atomic structure of time and the existence of an atomic unit of time, the so-called "chronon," of magnitude $4 \cdot 5 \times 10^{-24}$ sec. have been suggested by a number of authors [see Abstracts 910 (1927) and 47 (1929)]. The assumption of the existence of this time unit is shown to afford very close agreement between calculated and observed values of the wavelengths of lines in the penetrating radiation investigated by Millikan and Cameron.

J. S. G. T.

427. Heat-Tones in the Gravitational Field. A. Maior. *Phys. Zeits.* 29. *pp.* 739–741, *Nov.* 1, 1928.

Assuming that the mass of a body is constituted of its mass, M_0, at absolute zero, and M_T, which is dependent upon its temperature and is equal to U/C^2, when U denotes the body's internal energy at temperature T, an expression is derived for the absorption or emission of heat at constant temperature when the gravitational potential of the field surrounding the body is altered. Similar so-called heat-tones accompany the change of velocity of a body in a static gravitational field. The significance of both forms of heat-tones in the case of astronomical masses is suggested. [See Abstract 3059 (1927).] J. S. G. T.

428. Calculation of Aberration and Parallax According to the General Theory of Relativity in the Universes of Einstein, de Sitter and Friedmann. V. Fréedericksz and A. Schechter. *Zeits. f. Phys.* 51. 7–8. *pp.* 584–592, 1928.

It is shown that values of the aberration and parallax can be simply deduced by a transformation of coordinates in accordance with the general theory of relativity, either for a universe in which the earth and the infinitely distant stars are at rest, whilst bodies between these are in motion, or for a universe in which the earth is conceived as rotating round the sun, whilst the fixed stars execute a translatory rotation of which the period is equal to that of the rotation of the earth round the sun. Values of the aberration and parallax are deduced for the universes conceived respectively by Einstein, de Sitter and Friedmann. The expressions deduced agree, to a first approximation, with the customary astronomical expression. J. S. G. T.

429. Deflection of Light in the Neighbourhood of the Sun. G. v. Gleich. *Zeits. f. Phys.* 51. 9–10. *pp.* 740–753, 1928.

From analogy between the motion of a particle in a central gravitational field and the refraction of a light ray in a refracting medium, the author deduces an expression for the refractive index of the medium as a function of the radius vector. Soldner's value for the deflection of a light ray and the values obtained by Crommelin and Davidson are discussed. The latter values are held to be not in accord with deduction from Einstein's theory. A dispersion formula $1/n^2 = 1 + \beta/r + \gamma/r^2$ is shown to afford better agreement between experimental and calculated values. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

430. Effect of Ozone on the Temperature of the Upper Atmosphere. E. H. Gowan. *Roy. Soc., Proc.* 120. *pp.* 655–669, *Oct.* 1, 1928.

The paper deals with the radiative equilibrium of the upper part of the atmosphere, taking into account the effects, with selective absorption, of water vapour and ozone. For material the author used (1) Abbot's curve for the distribution of energy in the solar spectrum from 0·4 to 1·2 μ and a black-body curve for 6200° K. for 1·2 to 6 μ; (2) average radiation as for a black body at 260° K. from the earth and a moisture-laden atmosphere below 11 km.; (3) the amount of O_3 as constant and equal to a thickness of 3 mm. at N.T.P. with a centre of gravity at 30–40 km.; (4) a smooth average curve for absorption of O_3; (5) Fowle's figures for the absorption of H_2O vapour; and (6) saturation at 11 km. for 219° K. for H_2O vapour. Curves show the results obtained for temperature and height for (1) absorption and radiation due to H_2O vapour alone; (2) the observed amount of O_3 distributed as for O_2 down to 40 km.; and (3) an assumption of a change in distribution of O_3 to keep the temperature at 300° K. up to 150 km. The effects on the temperature of (1) a different H_2O vapour distribution; (2) variation of absorption with temperature and pressure; and (3) a change in the centre of gravity of the O_3 are discussed. The final temperature distribution arrived at agrees well with sound ranging and meteor observations. R. S. R.

431. Observation, Recording and Prediction of Storms by Means of Electric Waves. A. Turpain. *R.G.E.* 24. *pp.* 584–587, *Oct.* 20, 1928.

Describes several recorders controlled by a coherer by means of which atmospheric disturbances are registered. H. H. H.

ASTROPHYSICS.

432. Relation between the Form of the Solar Corona and Sunspot Frequency. H. Ludendorff. *Preuss. Akad. Wiss. Berlin, Ber.* 16. *pp.* 185–214, 1928.

It has long been recognised that the form of the corona varies with the sunspot cycle, being approximately circular at the time of maximum and markedly flattened at the poles at minimum. A detailed examination of photographs of thirteen total solar eclipses between 1893 and 1927 adds to our knowledge of this relation. When an isotope is drawn through the corona (a curve joining the points of equal brightness), and this is compared, not with the sunspot phase, but with the number of sunspots then actually upon the sun, a close numerical relation is found to exist. When spots are many, the flattening of the isotope at the poles is very slight; when spots are few, the flattening is still slight close to the sun's surface, but it increases rapidly with increasing distance, and the increase is approximately proportional to the distance. Marked irregularity in the distribution of spots on the sun has also a distinct influence on the form of the corona. M. A. E.

433. Equilibrium of the Calcium Chromosphere. W. H. McCrea. *Roy. Astron. Soc., M.N.* 88. *pp.* 729–740, *Oct.*, 1928. *Supplementary Number.*

The author criticises the results obtained in a paper by P. A. Taylor [see Abstract 2839 (1927)], since (1) the Schuster-Schwarzschild approximation, when applied to a spherical atmosphere, requires too high a density of radiation if the net flux is to be conserved; and (2) the assumption of constant T_0 leads to a chromosphere with finite density at infinity. Radiative equilibrium and a back radiation tending to zero require a density tending to zero. A temperature gradient is thus required, and $T \alpha 1/r^2$ is suggested. This gradient can be derived from the properties of a gas. Equations analogous to those of Taylor are developed, and values are obtained differing little from Taylor's except when r is large. R. S. R.

434. Extinction Factor in Photometry. P. Guthnick. *Preuss. Akad. Wiss. Berlin, Ber.* 20. *pp.* 249–257, 1928.

It is pointed out that the extinction factors in photometric observations made with the aid of electric light only slowly vary with variations in the level of the place of observation, and the extinction formula used by Stebbins at Mount Hamilton is criticised. A note follows on the colour indices of Jupiter's satellites, as determined by Stebbins and by the author. The paper is in reply to one by Stebbins and Jacobsen, Lick Observatory Bulletin No. 401. M. A. E.

435. Photographs of the Brighter Planets by Light of Different Colours. W. H. Wright. *Roy. Astron. Soc., M.N.* 88. *pp.* 709–718, *Oct.*, 1928. *Supplementary Number.*

436. Report on Preparations for the Photographic Survey of the Heavens. P. Guthnick. *Preuss. Akad. Wiss. Berlin, Ber.* 20. *pp.* 258–269, 1928.

The plan of this survey, which was sketched in the *Berlin Ber.* 1926, XXI, is here reported in detail, and the instrumental equipment is described. Operations have begun at Sonneberg and Babelsberg, and they are yielding notable results. At Sonneberg 284 new variable stars have been discovered, mostly faint; at Babelsberg stars brighter than the 13th magnitude have been surveyed, and 63 new variables have been discovered. The galactic distribution of the two classes of Beta Lyræ stars has been investigated, and is found to resemble the distribution of the short-period and long-period Delta Cephei stars. M. A. E.

437. Gravitational Motion in a Spiral Nebula. E. W. Brown. *Observatory*, 51. *pp.* 277–286, *Sept.*, 1928.

A few years ago the author outlined a gravitational system to account for the apparent internal motions in spiral nebulæ which had been measured by van Maanen [see Abstract 1588 (1925)]. Since that time observations have been made by Slipher, Hubble and others which indicate that the distances of spiral nebulæ are far too great for this kind of motion to be perceptible, that they consist (mainly, at any rate) of discrete stars, and that they are rotating almost like rigid bodies. A new system has, therefore, been worked out, partly from observations and partly from mathematical considerations. The latter suggest a simple dominating field of force: that of the direct distance was chosen, and it requires uniform density of distribution in the form of an ellipsoid. The full analysis will be published elsewhere, and the theory can be quantitatively tested in various ways. Spiral nebulæ are here assumed to be ellipsoidal aggregates of stars, which are very numerous, and at distances from one another very great in comparison with their diameters; each star is rotating with nearly the same angular velocity about the axis of symmetry of the ellipsoid. A near approach of another nebula will disturb the field by a kind of tidal force, and one effect will be to produce variations of density which have a maximum along one axis in the equatorial plane: this gives the appearance of a bar, and the altered gravitational field causes the bar to coil into a spiral. But during the process the arms of the spiral become so dense, and the coiling becomes so close, that the nebula reverts substantially to its original condition. If, however, before this, a near approach to another nebula takes place, a new pair of arms will be started, and the intersections of the two pairs will appear as knots. It seems improbable that there is a dominating central mass. M. A. E.

438. Spectroscopic Evidence of the Fall of Meteors into Stars. H. Shapley and Cecilia H. Payne. *Harvard Coll. Obs. Circ. No.* 317. *pp.* 1–11, 1928.

The authors show that solar radiation may be retarded and in rich meteoric regions the radiative degradation may be reversed by the meteoric infall. Particles falling directly on the sun at its surface have parabolic velocities of 622 km./sec. and proportionately higher speeds at more massive stars. The authors seek the consequences on the quantity and quality of stellar light from several thousand tons of iron and stone meteors falling into the photosphere with velocities of over 1000 km./sec. They recognise absorbtion bands of cyanogen (the characteristic radiation of comets) in Vega and other very hot stars, with widening of the bands both to the red and the violet, which is explained by the Doppler shifts due to the high meteoric velocities. Cyanogen absorption is most manifest in the nebulous regions like the Pleiades, showing that these are meteoric, not gaseous. A table gives the prominent lines of Fe and Mg (the principal constituents of meteorites) in the region 3600–3900, which do not normally appear in the atmospheres of very hot A, B and O stars, but are observed as wide, shallow, structureless bands. Diagrams are given for α Eridani, α Cygni, Vega, Rigel, Merope, Alcyone and α Centauri. The total displacements of the band heads (giving the relative maximum velocities of the absorbing meteors) indicate masses and diameters for stars of the right order. [See *Harvard Coll. Obs., Bull. No.* 862. *pp.* 1–3, *Dec.* 1, 1928.]
A. S. D. M.

439. Pressure in Stellar Atmospheres. Cecilia H. Payne and F. S. Hogg. *Harvard Coll. Obs. Circ. No.* 334. [8 *pp.*], 1928.

A table and curve summarise the numerical results from the observed contours of spectral lines of 69 stars (including the sun), and give log NH (number of effective atoms per square centimetre column) for the lines H, K, and 4227. The values of log NH (total ionised calcium) derived from H and K separately show that the ratio in width is 1 : 1·4, as predicted; K has been used for the hotter stars, and for the coolest only the H line of Ca^+. Unsöld's formula is adopted, but any exponential formula would accord with the observed shape, since the number of effective atoms enters in the same way into all. The authors use this table to estimate the pressures in stellar atmospheres whose neutral and ionised lines have been measured. From it log (X_2/X_1)—that is, the log of the ratio of ionised to neutral calcium—can be found, and also the partial electron pressure (P_e), if the stellar temperatures are known. They give a table of log P_e and log g and two series of assumed temperatures (Miss Payne's and that of Russell, Dugan and Stewart), but the first gives improbably small pressures for M stars, and the second is adopted. A correlation is found between P_e and surface gravity. A third table gives the calcium content of stellar atmospheres, and shows that the total number of calcium atoms is almost constant from G_0 to M_7 (and probably for hotter stars), and equals $10^{19\cdot6}$ atoms per square centimetre column. On this basis, for stars G_0 to M_7, the partial electron pressures and calcium (only) pressures are found; the difference between these increases as the temperature falls. [See Abstract 2645 (1928).]
A. S. D. M.

440. Extension of Period-Spectrum Relation. H. Shapley. *Harvard Coll. Obs., Bull. No.* 861. *pp.* 1–5, *Oct.* 1, 1928.

A curve of the relation of spectral class to log of the period is given for

(89) Cepheids (unpublished), RV Tauri, and M variables (which also include N, R and S). Spectra near the maximum are used for the Long-Period variables, and median spectra for the Cepheid and RV Tauri classes. From this curve the author tabulates the log of the period, mean spectral class, number of stars at each point, and the log of the effective temperature corresponding to each value of the mean spectrum. On a second curve he plots the temperature against the log of the period, and finds scattering and uncertainty in the region between Cepheids and Long-Periods, indicating low stability similar to that between cluster-type and ordinary Cepheids. He also finds that the period-luminosity law does not apply strictly to M variables, but that $P^{2}_{\rho} =$ constant does hold good approximately, and that they show bolometric luminosity of the same order as Cepheids. He concludes that the pulsation hypothesis may be extended to Long-Periods because of their similarity to Cepheids: in bolometric absolute magnitude, in their radiation variation, in their spectral peculiarities, and in their galactic distribution. Their dissimilarities he attributes to their differing stages in the evolution of the two groups. [See Abstract 2964 (1928).] A. S. D. M.

441. "Degeneration" of Electrode Gases in the Interior of Certain Stars. W. Anderson. *Zeits. f. Phys.* 50. 11–12. *pp.* 874–877, 1928.

In the interior of our sun and many other stars the degeneration is so small as to be negligible. But it is not to be ignored in certain stars of exceptional density, *e.g.*, Sirius B. A. D.

442. Some Additional Statistical Properties of Cepheid Variables in the Milky Way. J. Schilt. *Astron. J.* 38. *No.* 910. *pp.* 197–202, *Oct.* 16, 1928.

In a previous paper [see Abstract 599 (1927)] the author pointed out a number of objections to the validity of the relation between period and absolute magnitude for Cepheid variables, known as the period-luminosity curve, based on the consideration of data concerning apparent magnitudes, proper motions, and mean parallaxes. In the present paper he shows that there are good reasons to regard the variable stars, having Cepheid-like light curves with periods longer than the cluster-type variables and shorter than the Mira stars, as constituting more than one group. Especially a more restricted group having statistical properties which are not shared by the Cepheids at large is found to be present amongst the Cepheids having periods less than ten days. This group is identified with the *c*-stars and is outstanding among all known stars on account of the high absolute luminosity. AUTHOR.

443. Multiple System Ho 212 = 13 Ceti AB. A. Pogo. *Astrophys. J.* 68. *pp.* 116–144, *Sept.*, 1928.

This investigation is based on 100 Yerkes spectrograms of Ho 212 = 13 Ceti AB (98 one-prism and 2 two-prism plates taken with the Bruce spectrograph attached to the 40-in. refractor) and on the measures of 7 Lick plates and 3 Mount Wilson plates. Aitken's elements of the visual orbit are used. The short period, derived from 21 years of spectrographic observations, is $P = 2{\cdot}08186$ days. The orbital elements, derived from 15 plates secured in 1923, are: $\gamma = +\ 18{\cdot}4$ km./sec., $e = 0{\cdot}015 \pm 0.018$; $K = 41{\cdot}6 \pm 0{\cdot}7$ km./sec.; $a \sin i = 1{,}180{,}000$ km.; mass function,

$0 \cdot 0153 \odot$; and from 19 spectrograms taken in 1927–28 are: $\gamma = +13 \cdot 5$ km./sec.; $e = 0 \cdot 022 \pm 0 \cdot 018$; $K = 37 \cdot 1 \pm 0 \cdot 8$ km./sec.; $a \sin i = 1{,}070{,}000$ km.; mass function, $0 \cdot 0114 \odot$. The orbit is considered circular; the phases are counted from $T_{\text{min.}} = 1906$ Sept. 30·250 G.M.T. = J.D. 2417484·250, corresponding to the passage of the brighter component of the spectroscopic binary through the descending node. The positive sign of the inclination of the visual orbit is derived from spectrographic and micrometric observations preceding and following the epoch of periastron passage of 1912·15. The masses of the visual system are estimated hodographically, using Aitken's elements, a parallax 0″·05, and the range of the γ-values corresponding to the nodes of 1911·98 and 1912·64. The mass of the spectroscopic binary is found to be $1 \cdot 22 \odot$, the mass of the visual companion $1 \cdot 12 \odot$. Total mass of Ho 212: spectrovisual method, $2 \cdot 34 \odot$; dynamical, $2 \cdot 39 \odot$. The absolute magnitude of the spectroscopic binary is found to be 3·8. The amplitude of the short-period oscillations shows apparent variations, from less than 35 to more that 41 km./sec.; the variations of the velocity of the centre of mass of the spectroscopic binary do not correspond to the visually observed elliptical motion. Two explanations of these irregularities are offered: (1) If the spectrum belongs to the bright star A only, there may be masking effects of physical changes in the atmospheres of its two components; (2) if the spectrum belongs to both components of the visual system, the fainter star B may be a close binary B′B″. AUTHOR.

444. Determination from Binary Star Data of the Giant and Dwarf Branches of the Russell Diagram. R. O. Redman. *Roy. Astron. Soc., M.N.* 88. *pp.* 718–729, *Oct.*, 1928. *Supplementary Number.*

The general outlines of the Russell diagram indicate a relation between the spectral type and the absolute magnitude for both giant and dwarf stars. From a consideration of the available data the scatter of the absolute magnitude is found to be less for giants than for dwarfs. The results for the determination of the central line of the dwarf branch of the Russell diagram are considered satisfactory although derived from a very small amount of data. The giant result is not so certain, although three reliable points from individual stars agree, but otherwise there is no good check. The method is expected to be valuable when more spectral determinations become available. The average spread from the centre line of the main series ($F_0 - K_0$) is probably about ± two-thirds of a magnitude. R. S. R.

LIGHT.

445. Recent Work on the Light of the Night Sky. (Lord) Rayleigh. *Nature*, 122. *pp.* 315–317, *Sept.* 1, *and pp.* 351–352 *and* 373, *Sept.* 8, 1928.

In contrast with daylight, the light from the night sky has very little polarisation, while the intensity is below the threshold of vision. The green auroral line is present against a background of an apparently continuous spectrum, and is shown by a photographic method. By means of filters the green line and the regions on the red and the blue sides were separated. The filtered light was matched with a standard self-luminous source consisting of crystals of potassium uranyl sulphate. Observations were obtained at fourteen stations distributed over the world and on two ocean voyages. The mean values of intensity of the three components are red — 2·5, auroral 0·8 and blue 8·5, according to a scale where 0 gives a match without the interposition of neutral glasses. There is a 3- to 4-fold range for each component. The results obtained between 1923 and 1928 indicate an annual range with a minimum between November and December and an amplitude of about 2 units. This is probably due to the sun's motion in declination. There has been a yearly increase in the five years in agreement with the sunspot cycle. Finally, the effects of the polar aurora are distinguished from non-polar aurora, the former occurring only in auroral zones and the latter all over the earth. In future measurements a photoelectric cell is to be used to get greater accuracy in the photometer measurements. R. S. R.

446. Effect of Age on the Sensitivity of the Human Eye. P. Lasareff. *Zeits. f. Phys.* 50. 11–12. *pp.* 756–761, 1928.

Observations show that for dim vision the maximum sensitivity of the eye is small at about 4–6 years of age, increases to a maximum at 18, and falls off with increasing age until at 80 years it is only about 25 % of the maximum. This is explained as follows: Nerve-cells do not exhibit a splitting process, so that their number cannot be greater in adults than in children. In every cell there is an insensitive substance A, which passes over into a sensitive substance B, and this in turn to an insensitive substance D. The quantity of B in each functioning nerve-cell is constant, and the sensitivity E_0 takes the form $E_0 = M_0\{e^{-a_1 t} - e^{-a_2 t}\}$, where t is the age and the other quantities are constants. This formula is supported by the experiments. The formula involves the prediction of the age at which the eye "dies," and it works out to between 130 and 180 years of age. This agrees with the results of other anatomical considerations. A. C. M.

447. Quantum Theory and the Analysis of Observations. F. J. Selby. *Phil. Mag.* 6. *pp.* 801–806, *Nov.*, 1928. *Supplement.*

The methods of analysis of the more delicate observations of modern physics, in which electrons and protons, waves and radiation are involved, are considered. In all such observations the eye, as sense organ, is directly or indirectly concerned. The eye receives a succession of wave-groups associated with a certain frequency, the group or beat frequency; it responds by resonance after a very brief interval. The natural measure of the response is, therefore, of dimensions energy × time, *i.e.*, of action. Suppose that there is a certain minimum of response, the quantum of action, which is perceptible by the eye and the mind behind it; then, on tracing back the phenomenon to its objective end, the quantum of action must be retained as an indivisible unit. The reason for the appearance of the quantum in all visual phenomena is then realised; it is inherent in ourselves. J. J. S.

448. Extension of Schrödinger's Theory of Colorimetrics. Johanna C. T. van Velzen. *Ann. d. Physik*, 87. 1. *pp.* 31–54, *Oct.* 5, 1928.

Schrödinger's equation for the brightness sensation, $h = x_1 + x_2 + x_3$, where the x are functions of the fundamental colours [see Abstract 856 (1921)], did not cover the Purkinje phenomenon, as he himself accentuated. König's comparative measurements respecting this phenomenon were made by examining waves (*e.g.*, of $\lambda 535\ \mu\mu$) through a slit of definite width and by adjusting the slit width of another colour range in the other spectrum for the same brightness. The determination of the equivalent slit width s_λ is a matter of great difficulty. The author calculates from König's s_λ the equivalent energies p_λ, producing the same brightness sensation, and shows that the heterochromic comparisons of König are justified and that the brightness of a colour is a mathematical quantity. Expressing by D the proportionality factor for red, green and blue, he arrives at the formula $h = x_1^{R/D} + x_2^{G/D} + x_3^{B/D}$, which accounts for the Purkinje phenomenon and agrees with the energy distribution in the solar spectrum. H. B.

449. Transitions between Different Modes of Union from Light Absorption in the Dissolved State. G. Scheibe. *Zeits. f. Elektrochem.* 34. *pp.* 497–502; *Disc.*, 518–520, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

In this investigation the absorption was determined exclusively in the visible and ultra-violet regions. The following types of union were studied: When the molecule contains a chromophore which is not directly concerned in bond change in other parts of the molecule, *e.g.*, phenol, or is directly associated with bond change, *e.g.*, alkyl esters of the halogen acids, or experiences itself a transformation, *e.g.*, keto-enol tautomerism. The problem is discussed with examples as to whether the transition between homopolar and heteropolar union is gradual or abrupt. It is concluded that homopolar and heteropolar unions occur in solutions of the halogenides of the mercury series in equilibrium with each other, and that through varying degrees of deformability the solutions exhibit the transitions in properties now recorded. The absorptions by halogen ions, whether present in heteropolar molecules or in the solvate state, exhibit no characteristic differences, thus indicating these two forms of union to be similar whilst varying from the homopolar type. H. H. Ho.

450. Cases of Complete, Partial and Zero Validity of Fermat's Theorem. C. Raveau. *J. de Physique et le Radium*, 9. *p.* 236, *July*, 1928.

The path of a ray A I A′ from A to A′ with refraction at I is always optically shorter than an adjacent path A J A′ if A′ is near to I. The minimum exists only when A′ is between I and the corresponding focal point, provided J is in one of the principal planes of a small pencil of rays which arises from a homocentric pencil of rays coming from A. In nine general cases, when I and A′ occupy different positions with respect to the two focal points, the theorem is valid for three when A is sufficiently near to I. It is partially correct for four cases, and is incorrect in the remaining two, when the optical length of the ray is a minimum. R. C. F.

451. Refractive Index of Sodium Vapour and the Width of the D-Lines in Absorption. J. Q. Stewart and S. A. Korff. *Phys. Rev.* 32. *pp.* 676–680, *Oct.*, 1928.

Employing classical methods, a theoretical relation is developed between the refractivity of sodium vapour near the D-lines and their observed width in absorption. A preliminary experimental test of this relation is described. The method involved observation of the wave-lengths of interference fringes produced by sodium vapour when a Michelson interferometer was used in conjunction with a spectroscope and a source of white light. This is a convenient means of determining refractivity in cases where it varies rapidly with wave-length. The approximate observations verify the classical theory, and serve to give a determination of e^2/mc^2, which is correct in order of magnitude. As regards the scattering of radiation, therefore, sodium atoms may be considered as behaving in a manner analogous to Hertzian oscillators. Further experimental study is planned. AUTHORS.

452. Deformation of Ions and Molecules from Refractometric Data. K. Fajans. *Zeits. f. Elektrochem.* 34. *pp.* 502–518; *Disc.*, 518–520, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

This paper commences with a general discussion of the transitions between the ideal ionic union and the non-polar bond and with deformation phenomena produced in varying degrees by the influence of kation upon anion. § 2 describes changes in refraction obtained with composite systems, and considers the influence of ions of the inert gas type, transitions between the ideal ionic and non-polar unions as indicated by refraction data, the influence of dissolved ions upon the solvent molecules, the interaction of ions in solutions of strong electrolytes, and the interaction of neutral molecules. § 3 considers the refractometric behaviour of salts with kations dissimilar to the inert gas atom. The various influences are shown to produce greater or less deviations from the Lorentz-Lorenz function of additivity for which quantitative data are submitted. In the *Discussion*, **A. Sommerfeld, G. Tammann, K. Fajans, H. G. Grimm, G. E. Gibson, F. Hund, P. Debye, G. Scheibe, H. v. Halban** and **Kasarnowsky** took part. H. H. Ho.

453. Anomalous Dispersion in Vapours of Ca, Sr, Ba. W. Prokofjew. *Zeits. f. Phys.* 50. 9–10. *pp.* 701–715, 1928.

The anomalous dispersion has been investigated in the neighbourhood of the lines $1^1S_0 \rightarrow 2^1P_1$, $1^1S_0 \rightarrow 2^3P_1$. The ratio of the number of dispersion-centres for the first and second lines decreases very rapidly with increasing atomic number. Setting the probability of the spontaneous transition $2^1P_1 \rightarrow 1^1S_0$ equal to unity, the relative probability of the transition $2^3P_1 \rightarrow 1^1S_0$ taking place spontaneously is given by $\left(\frac{\Delta\nu}{\delta\nu}\right)^{2\cdot 44}$, where $\Delta\nu$ is the term-difference $2^3P_2 - 2^3P_0$, and $\delta\nu$ is the difference 1^1S_0 (centre of gravity of the $2^3P_{0,1,2}$ terms). Results for Cd and Hg by other authors fit this relationship also. The relative probabilities for the intercombination lines of Mg and Zn are also calculated from the formula above. A. C. M.

454. Corpuscular Theory of Interference and Refraction. G. Wataghin. *Zeits. f. Phys.* 51. 7–8. *pp.* 593–604, 1928.

A quasi-corpuscular theory, in which quanta are directed along the lines of energy-flow. Exact, not approximative, and in agreement with the ordinary wave theory. A. D.

455. Internal Field of Polarisation. R. de Mallemann. *Comptes Rendus,* 187. *pp.* 720–722, *Oct.* 22, 1928.

In a recent paper [see Abstract 99 (1929)] a general method was established for calculating the internal field from specific properties of the molecules, this being essentially an heterogeneous effect which is zero for a perfectly regular assembly. The classical method of calculation due to Lorentz is now shown to be inexact by the rigorous methods of electrostatics, and supplements the author's previous demonstration by the direct molecular method. The present discussion is, however, limited to the case of isotropic bodies, the example of a dielectric sphere immersed in an unlimited medium of given inductive power being taken. A new formula for refractive power is derived which closely approaches the empirical relationship given by Gladstone, the validity of which is, therefore, supported on theoretical grounds. H. H. Ho.

456. Interferential Measurement of Small Particles in the Ultramicroscope. U. Gerhardt. *Ann. d. Physik,* 87. 1. *pp.* 130–144, *Oct.* 5, 1928.

After a brief description of the experimental arrangement used, the principal results of theory and experiment for self-luminous and non-self-luminous particles are summarised and discussed. The case of the latter is then dealt with more fully and the effect of the form factor explained for a point source and for a ring-shaped light source. It appears that particles of diameter 270 mμ can certainly be measured by this method and probably also down to 120 mμ. Certain effects described by Bechmann [see Abstract 295 (1928)] were never observed. [See Abstract 3089 (1927).] A. W.

457. Molecular Theory of Scattering of Light by Liquids. Y. Rocard. *Ann. de Physique,* 10. *pp.* 116–179, *July–Aug., and pp.* 181–231, *Sept.–Oct.,* 1928.

The diffusion of light is calculated, (i) neglecting, and (ii) allowing for the intermolecular field, by means of a model involving two characteristic constants, whereas Langevin's model involves only one, the anisotropy of the molecule. This model can be visualised as a molecule consisting of oscillating isotropic ions. If the ions do not oscillate the model becomes identical with that of Langevin. A precise agreement is claimed on applying these results to the scattering of light by gaseous ethyl chloride, water, ether and benzene. The values deduced for the Avogadro constant agree closely with the experimental values. T. M. L.

458. Effect of Molecular Force and Association on Light Scattering in Liquids. Part I. Fatty Acids and Alcohols. Part II. Some Aromatics. S. R. Rao. *Indian Journ. Phys.* 3. *pp.* 1–30, *Sept.* 30, 1928.

The variations of intensity and the depolarisation factor of the transversely scattered light are studied in methyl, ethyl, propyl and butyl alcohols and in nitrobenzene, aniline, ethylbenzene and bromobenzene. Graphs show the changes in the values of the depolarisation factor with temperature. Calculated and observed intensities show a closer agreement in the case of ethyl alcohol than in the case of acetic acid. The optical anisotropy in methyl alcohol shows a high value at ordinary temperatures, with a rise becoming very slow at high temperatures, while the higher alcohols show almost steady values at ordinary temperatures; the fatty acids behave very peculiarly, acetic acid showing a rapid fall in the optical anisotropy with increasing temperature and then a gradual rise, while propionic and butyric acids show an initial rise and fall and later a gradual rise. In the aromatics the calculated and observed values of the intensity do not agree. In nitrobenzene and aniline the optical anisotropy diminished as the liquids were heated up to a certain temperature and then rose with increase of temperature; this behaviour, as well as the anomaly in the case of the intensity, are suggested to be due to molecular association. A third part will give theoretical deductions. A. D.

459. Scattering of Light in Crystals. G. Landsberg and L. Mandelstam. *Zeits. f. Phys.* 50. 11–12. *pp.* 769–780, 1928.

In quartz and calcspar every ground-line of the incident light (mercury lamp) is accompanied by several " trabants," spread partly towards the red, partly towards the violet, and forming in the aggregate a system of lines. In each system the difference $\Delta\nu_1$ between the frequencies of the trabants and those of the ground-lines is the same for all ground-lines. This shows that this difference corresponds to a proper frequency ν_1 of the crystal itself. So far, five such systems have been found in quartz and two in calcspar. The relation between the proper frequency of the crystal, so found, and the infra-red frequency of the crystal, is discussed. The intensity of the violet trabants, relative to the red, increases with increasing temperature. A. D.

460. Solid Dipleidoscope Prisms. C. V. Boys. *Roy. Soc., Proc.* 121. *pp.* 1–8, *Nov.* 1, 1928.

In a previous paper [see Abstract 2665 (1928)] the prisms described were essentially dipleidoscopic about a plane. A glass tetrahedron is now described which is dipleidoscopic about an axis, and it is pointed out that a transit instrument with a tetrahedron suitably mounted in the place of a prism could be used with a telescope as a mere viewing and magnifying machine to determine both time and declination ; or, if the tetrahedron were mounted in a cage with a declination axis and circle carried on a polar axis and a viewing telescope were provided, such a tetrahedron would provide the direction factor of an equatorial. The method of strip-silvering previously described is shown to be particularly advantageous in the case of the prisms of 90°, 45°, and 45° used dipleidoscopically. Some new prisms are then discussed, following which comes an outline of design of a new type of transit instrument which appears to the author to be more suitable for time observations of the highest precision than transit instruments of recognised design. H. H. Ho.

461. Visual Performance of Telescopes. A. Kühl. *Zeits. f. Phys.* 51. 5–6. *pp.* 429–442, 1928.

The approximate functional correlation of the laws of Ricco and Piper is deduced by the aid of Löhle's observations of the threshold stimulus of white circular discs. Löhle's telescopic determinations of acuity of vision are compared with those relating to the naked eye, and afford, in conjunction with König's observations, a basis for the postulation of the existence of general constants in the expression of visual acuity as a function of the intensity of illumination. [See also Abstracts 1711 (1927) and 1875 (1928).]

J. S. G. T.

462. Optical Oscillograph. S. Smith. *Mt. Wilson Observat. Contrib. No.* 366. *Astrophys. J.* 68. *pp.* 165–168, *Sept.*, 1928.

A beam of light, after passing through a Nicol prism, a quartz plate (perpendicular to the axis), a CS_2 cell, and a second Nicol, is photographed with a rotating-mirror spectograph. The current to be studied is carried by a solenoid which surrounds the CS_2 cell. The first Nicol renders the light plane-polarised, the quartz plate rotates the plane of polarisation, and the CS_2 cell adds to, or subtracts from, the rotation, depending on the current through the solenoid. The second Nicol removes from the beam all wave-lengths which have suffered a rotation of $n\pi$, where n is an integer. Thus, if the light coming through the second Nicol is viewed through a spectroscope, the spectrum is seen to consist of a series of bright and dark bands, the position of the dark bands depending on the current through the solenoid. If the light is photographed with a rotating-mirror spectrograph while a non-uniform current is flowing through the solenoid, the fluctuations of the current are reproduced on the film. AUTHOR.

463. Depolarisation of the Secondary Radiations in the Complex Light resulting from Molecular Diffusion of a Monochromatic Radiation. J. Cabannes. *Comptes Rendus*, 187. *pp.* 654–656, *Oct.* 15, 1928.

If we illuminate a liquid with different radiations N, N^1, . . ., all the secondary rays $N - n_1$, $N^1 - n_1$, . . ., relative to a given diminution of frequency, have the same depolarisation. This depolarisation varies within wide limits according to the diminution of frequency considered; it may be less (or greater) than the depolarisation of the radiations diffused without changes of wave-length. It is as though the incident light were unchanged by the greater part of the molecules, but a certain number of the molecules cause one diminution of frequency, others another, and as though these groups were determined by the orientation of the members of the group. A. D.

464. Effect of Neutral Salts on the Rotatory Power of Tartaric Acid and the Tartrates. E. Darmois. *Ann. de Physique*, 10. *pp.* 70–115, *July–Aug.*, 1928.

Observations of the rotatory power of tartaric acid in presence of calcium chloride, in relation to the pH of the solution, cannot be interpreted on the hypothesis of a molecule and ion of constant optical rotations. To account for the variations it is necessary to postulate the existence of two forms of the undissociated acid. In these experiments the electrolytic dissociation of the acid was deduced from comparative measurements of the pH of solutions of hydrochloric acid (for which 100 % dissociation was postulated), and values $2\frac{1}{2}$ times greater than in pure water were found. Neutral tartrates give for the tartaric ion the limiting value $[\alpha]_{5785} = 43°$ in dilute solutions, but in strong solutions the rotations of the Li and Na salts decrease, whereas those of the Am, K, Rb and Cs salts increase. Observations were also made of the influence on the rotatory power of an alkaline tartrate of added salts, *e.g.*, Li salts added to Li-tartrate, and of the addition to sodium tartrate of *bivalent* salts of Ca, Sr, Ba, Mg, Zn, Cd, Hg, Fe, Mn, Cu, *tervalent* salts of La, Ce, Al, Fe, and *quadrivalent* salts of Th and Ce. The variations of rotatory power thus produced are attributed to (i) dehydration of the tartaric ion in the presence of ions of other salts, causing an increase of rotatory power; (ii) deformation of the tartaric ion in the field of other ions, and especially of kations, an important effect sometimes leading to a complete reversal of rotatory power; (iii) association of the two ions of the tartrate, especially with polyvalent kations.

T. M. L.

465. Anomalous Magnetic Rotation in Excited Neon. R. N. Jones. *Phys. Rev.* 32. *pp.* 681–688, *Oct.*, 1928.

The anomalous magnetic rotation of the plane of polarisation was observed near twenty lines belonging to the transition $s_3 - p_k$, $s_4 - p_k$, and $s_5 - p_k$. Quantitative measurements were made of the angle of rotation for different frequencies near sixteen lines. The effect is the normal effect, symmetrical on both sides of the line, the direction of rotation being negative. From the angle of rotation the dispersion constants were determined, using the formula derived by Kuhn. This formula requires a knowledge of the relative intensities in the longitudinal Zeeman effect. These were calculated from the theoretical rules of Hönl, and were found to give good results. The relative transition probabilities, for absorption lines having the same lower state, were calculated from the ratios of the dispersion constants, using Ladenburg's formula. The values so found are, in general, in good agreement with the values determined by Kopferman and Ladenburg directly from the anomalous dispersion.

AUTHOR.

466. Measurement of the Velocity of Light by Means of the Kerr Effect. A. Karolus and O. Mittelstaedt. *Phys. Zeits.* 29. *pp.* 698–702, *Oct.* 1, 1928.

The principle of the method was similar to that adopted by Fizeau in his toothed-wheel measurements. Light was polarised by means of a Nicol in a plane of polarisation inclined 45° to the electrical lines of force of a Kerr cell containing nitrobenzole; the resulting elliptically polarised light passed through a second Nicol turned through 90° with regard to the first, and reached a system of mirrors by means of which it was reflected up and down a corridor, and finally through a second Kerr cell and Nicol, the total path being 332 m. The two Kerr cells were placed in parallel with the capacity of the oscillation circuit of a valve transmitter, and the connections were made as symmetrical as possible, so that their electrical fields were in phase. The beam of light was thus periodically interrupted, and whether the pulses passed through the second Kerr cell and Nicol or not depended on the phase difference produced by their passage over the path between the two cells. This could be varied by altering the tuning of the valve and successive extinctions of the emergent light obtained as in Fizeau's experiment. A second optical arrangement of the Kerr cells and Nicols is described. The value 299,778 km./sec. ± 20 km./sec. was obtained for the velocity of light. Further measurements, with a distance of 3 km., are proposed.

H. N. A.

467. Topography from the Air. L. J. R. Holst. *Frank. Inst., J.* 206. *pp.* 435–470, *Oct.*, 1928.

Describes in detail the science of map-making from aerial photographs, considering actual practical applications. The production of the aerial photographs necessitates the use of the heavier-than-air machine, and owing to the fact that the machine is rarely horizontal at the time of taking the photograph, the method of comparing photographs is dealt with fully. This entails the determination of the position of the focal plane of each of the photographs with relation to the earth, and the conversion of the photographs to their equivalents in a horizontal plane of projection. These equivalent horizontal plane photographs are then assembled to the aggregate of the area surveyed, and this gives horizontal control of the map. The construction of the contour lines is next dealt with, after which the perspective view becomes unnecessary, and the central or conical projection of the photographs is converted to the orthogonal projection of the map. Finally, the drawing and reproduction of the actual map is described.
R. C. F.

468. Some Properties of Photographic Layers. F. Weigert and F. Lühr. *Zeits. f. Elektrochem.* 34. *pp.* 605–610; *Disc.*, 610–611, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May,* 1928.

Previous results of Weigert, together with those of Schoeller and Schubert, have led to the conclusion that the absorbing material in photographic layers is silver, and not halogen silver, as found by Eggert and Noddack [see Abstracts 1635 and 1636 (1925)]. From a discussion of the results which have led to these conclusions, it is stated that the quantum law for photographic layers, accepting halogen silver as the absorbing medium, is still not experimentally confirmed. Further work on halogen silver emulsions is described, in which Cox's differential electrometric titration method was used, in which " Ursilver "—obtained in unilluminated layers—is definitely shown to exist. The quantity of " Ursilver " increases when illuminated, and the difference gives the " Photosilver " formed. From the results obtained with normal and heated plates it is shown that the plate sensitivity to light is influenced by the " Ursilver," and thus Eggert and Noddack's conclusion is incorrect. In the *Discussion*, **Eggert** gave further experiments in support of his conclusion, and stated that these results proved that the quantity of silver found by Weigert was erroneous.
R. C. F.

469. Formation of the Photographic Latent Image. S. E. Sheppard. *Kodak Research Lab., Comm. No.* 359. *Phot. J.* 68. *pp.* 397–414, *Sept.*, 1928. *Hurter and Driffield Lecture.*

The latent image is an activity which is developable, but there have been many theories made as to its nature, ranging from the purely physical modification of the silver halide to the photochemical formation of minute traces of metallic silver. Considering the grain unit as an individual crystal, and plate and grain sensitivity, it is shown that it is the nature of the grain sensitivity which appears essentially in the formation of the latent image. Gelatine also contributes something to this sensitivity besides acting as a colloid restrainer of recrystallisation. From a discussion of details known about sensitising nuclei, nature of the sensitive silver halide grain, photochemical decomposition of the halide and as an inner photoelectric effect, together with unpublished results on the Becquerel effect, it is apparent that the active absorption of light is by the silver halide and that the sensitising nuclei need not optically sensitise. The experimental work carried out on the Becquerel effect consisted of measuring potential differences between two silver-silver bromide electrodes in a photo-voltaic cell, one electrode being illuminated and the other dark, photopotential curves thus obtained being carefully analysed. It is further shown that the chief function of the sensitising nuclei is to secure an earlier concentration of silver atoms to a nucleus large enough to induce developability. The mechanism of this concentration is dealt with fully, whilst, finally, the orientation hypothesis and optical sensitising and nucleus dispersion and reciprocity failure are considered. R. C. F.

470. Photolysis of Unsuspended Silver Bromides (Silver Determination). H. Kieser. *Zeits. f. wiss. Phot.* 26. *pp.* 1–46, *Oct.*, 1928.

Describes the results obtained from an analytical method for the quantitative determination of the photolytically formed silver in silver halide by the use of alkaline thiosulphate solution. The dependency of the analysis results on the conditions of the experiments are carefully examined, and it is found that the analysis must be made immediately after the lighting. Silver sulphide formation or loss of silver through incomplete coagulation adversely affects the results, and the error introduced is connected with the time of fixing and the quantity of fixing solution used. The best analysis results are obtained with the smallest quantity of thiosulphate bringing about solution. The silver values are calculated from the analysis results, provided those with excess silver sulphide content are neglected. From the results it is apparent that the silver sulphide formation gives the appearance of a development, and a parallel is drawn between the sulphide development and the photographic silver development. Silver bromide precipitates as bromide in sodium nitrate and water, and as silver in silver nitrate solution. The silver separation as bromide in nitrate is not connected with washing out of the precipitate or with the concentration of the acceptors, and ripening appearances also are not appreciable. A quantum gain of $\rho = 1$ is produced by the illuminated bromide in nitrate, and in water the gain is approximately $\rho = \frac{1}{15}$ for $\lambda = 4360$ Å., this quantum gain falling off rapidly for higher lighting periods, due to the screening action of the separated silver. Results for the absorption of the silver bromide for blue, green and red light, together with the increase of absorption with increasing illumination of these colours, have been obtained from reflection measurements.

R. C. F.

471. Halogen Silver Photochemistry. Part III. Relation between Gravimetrically-obtained Silver Values and the Reduction in Sensitivity produced by Dichromate and Sulphuric Acid. H. H. Schmidt. *Zeits. f. wiss. Phot.* 26. *pp.* 86–95, *Oct.*, 1928.

In Parts I and II [see Abstract 2685 (1928)] the results of the surplus silver and halogen ions after destruction with nitric acid, and the action of acid, neutral and alkaline hydrogen peroxide on photographic layers are dealt with. In this part the author first of all shows that the action of dichromate sulphuric acid on non-sensitised plates of different kinds of halogen silver is not a function of the silver values obtained analytically.

A direct function of the sensitivity is obtained, however, with chemical and primary-physical development, in which the decreases in sensitivity for the latter type of development are smaller than those for the former. If secondary-physical development is used, then the differences between control and dichromated plates are so small that the reduction in sensitivity of non-illuminated plates treated with dichromate sulphuric acid and followed by chemical or primary-physical development is apparently not due to a destruction of the development centres, but rather to a development phenomenon exhibited. Plates sensitised with acid dyes behave exactly as high-sensitivity non-sensitised plates for all types of development, but this is not the case for basic dye sensitised plates. A simple explanation of the large sensitivity difference between control and dichromate plates with secondary-physical development is that the basic dyes are driven out of the nucleus by the dichromate sulphuric acid, whereas the acid dyes are not. This results in a decrease in the general sensitivity.

R. C. F.

472. Sensitometry of De-Sensitised Films. H. Arens and J. Eggert. *Zeits. f. wiss. Phot.* 26. 4–6. *pp.* 111–126, *Oct.*, 1928.

A tridimensional-diagram method of calculating the theoretical, and recording the actual, degree of blackening. Both the position (transferred to the higher exposures) and the form of the resultant surface differ considerably in the de-sensitised plate from the plate not de-sensitised. A. D.

473. Colour Temperature of Burning Magnesium and Flashlight Powder. H. Arens and J. Eggert. *Zeits. f. wiss. Phot.* 26. *pp.* 95–96, *Oct.*, 1928.

Dziobek has stated that the colour temperature of burning magnesium is 3700° absolute [see Abstract 2114 (1928)], whilst the present authors have given the figure of 2900° absolute for the colour temperature of flashlight powder. This paper shows, by means of two densograms, the difference between these two lights. Both produce the same blackening over the range 4000–5000 Å., but above the latter wave-length flashlight powder gives higher densities than does magnesium, thus showing that it possesses more light in the yellow and red regions. The temperature value of 2900° absolute was obtained by comparison with a kinema projection lamp. It is because of this excess in the yellow and red regions of the spectrum that the colour temperature of burning flashlight powder must be considerably below that for burning magnesium. R. C. F.

474. Improved Arrangement for Integrating Photometer. B. P. Dudding and G. T. Winch. *Journ. Sci. Instruments*, 5. *pp.* 312–320, *Oct.*, 1928.

The paper gives details of a new simplified type of photometer head incorporating Lummer-Brodhun contrast prisms and a sector disc. The use of this head with an integrating photometer is described. When so used, a small portion of the internal surface of the integrator forms one half of the field of view and a comparison disc having an identical surface forms the other half, both surfaces being viewed at the same angle. The advantages of the arrangement are stated. AUTHORS.

475. Ultra-violet Fluorescence of IBr Vapour. A. Filippov. *Zeits. f. Phys.* 50. 11–12. *pp.* 861–873, 1928.

On illumination of IBr vapour with light of shorter wave-length than

2000 Å., a violet emission is observed consisting of a complicated system of bands. The addition of a different gas greatly modifies the results. The ultra-violet emission of IBr vapour is a consequence of stimulation of the IBr molecule. A brief discussion of the fluorescence of ICl vapour, and the electrodeless spectra of $I_2 + N_2$, $IBr + N_2$, $ICl + N_2$. A. D.

476. Phosphorescence, Fluorescence and Chemical Reaction. E. C. C. Baly. *Nature,* 122. *pp.* 651–654, *Oct.* 27, 1928. *From Presidential Address to the British Assoc., Glasgow, Sept.,* 1928.

It is pointed out that the condemnation of the radiation theory of photochemical action on the ground that the critical increment of energy is not absorbed as a single quantum, implies more detailed knowledge of the activation of a molecule than is possessed. Activation of a phosphore being due to radiation of higher frequency (ν_0) than that of the emitted luminescence (ν_1) it is suggested that the energy difference is emitted in single quanta as fluorescence of frequency ν_2 ($h\nu_0 - h\nu_1 = h\nu_2$). Recent experiments tend to show that fluorescence always accompanies photo-activation of a phosphore. Activation of a molecule is thus in two stages, and differs essentially from that of an atom. The two-stage theory is then extended to thermal reactions, based on the observations that the relation between temperature and yield in the reaction whereby carbohydrates are photo-synthesised from carbon dioxide in presence of nickel carbonate is linear, and that this reaction only occurs when carbon dioxide is adsorbed on a coloured surface irradiated by white light. The assumptions made are: (i) A complex is formed, one component of which supplies to the other energy equal to the critical quantum of activation, a condition which may be denoted as A^-B^+; (ii) this transfer is due to a reduction in the rotational energy of A, which can be made good by infra-red radiation; (iii) B^+ cannot react until the transferred energy of A^- is restored, and then (iv) does so with emission of fluorescence; (v) the complex is completely stable below a certain minimum temperature above which stability decreases, thus explaining the increase in intensity and decrease in persistence of fluorescence to a temperature above which neither fluorescence nor phosphorescence is possible. The theory is supported by the fact that an activated phosphore is best deactivated by exposure to infra-red radiation. C. A. S.

477. Retardation of the Green Fluorescence of Mercury Vapour. S. Pieńkowski. *Acad. Polonaise, Sci. et Lettres, Bull.* 6–7*a. pp.* 241–256, *June–July,* 1928.

From measurements on the time interval between the absorption and emission of fluorescence it is shown that the average interval for the green fluorescence of mercury excited by ultra-violet light from aluminium is of the order of 10^{-5} seconds. This value is in agreement with that obtained by Wood [see Abstract 1989 (1921)]. The value for the retardation is, however, dependent on the density, decreasing with increase in the density of the vapour. Microphotometric curves taken show that the intensity of the luminescence increases from the time of optical excitation, and reaches a maximum in a time which increases with decrease in the density of the vapour. The speed of increase of intensity, as well as that of extinction, varies directly as the mercury-vapour density. A hypothesis is suggested and confirmed by the above results, in which in the green mercury luminescence an evolution of the metallic molecule occurs due to collisions. The molecule is first excited by absorption, being incapable of fluorescing, then it passes through an unknown modification to the molecule capable of fluorescing, after which molecular collisions produce the green fluorescence [see also Abstract 2722 (1928)]. R. C. F.

478. Fluorescence and Absorption of a Mixture of Mercury and Zinc Vapours. J. G. Winans. *Phys. Rev.* 32. *pp.* 427–434, *Sept.*, 1928.

It was observed that the vapour distilling from slightly amalgamated zinc is excited by the aluminium spark of wave-length below 2000 Å, with emission of the first triplet of the sharp series of zinc. Pure zinc or the non-distilling vapour does not give this effect. The same mixture gave a continuous absorption from 2050 to < 1850 Å. in distilling but not in quiescence. This absorption is different from that of pure zinc and pure mercury. The fluorescence is emitted by 2^3S zinc atoms which have been produced either through absorption by HgZn molecules or through collisions of the second kind between normal zinc atoms and excited HgZn molecules. J. E.

479. Life of Excited Hg Atoms. T. Asada. *Phys. Zeits.* 29. *pp.* 708–710, *Oct.* 1, 1928.

A somewhat fuller account with corrections of work described in a previous paper [see Abstract 3245 (1928)]. F. S.

480. Propagation of Light in External Fields of Force. F. J. v. Wisniewski. *Zeits. f. Phys.* 50. 9–10. *pp.* 644–647, 1928.

The de Broglie wave equation is taken as applicable to light quanta, the mass m of a material being replaced by $h\nu/c^2$ for a light quant. Putting also $F = m \,.\, \phi = \frac{h\nu}{c^2}\phi$, where F = kinetic energy, ϕ = gravitational potential, the equation:

$$\text{(A)} \qquad \nabla^2 u - \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} + \frac{4\pi\nu i\,\phi}{c^4}\frac{\partial u}{\partial t} + \frac{4\pi\nu^2\phi}{c^6}u = 0$$

is obtained for the propagation of a light quant in a gravitational field. Whence, putting $u = u_0\,(x_1 y_1 z)\, e^{2\pi i\nu t}$, since $\frac{\partial^2 u}{\partial t^2} = -\,4\pi^2\nu^2 u$ and $\frac{\partial^2 u}{\partial t^2} = 2\pi i\nu \,.\, \frac{\partial u}{\partial t}$, the equation is obtained:

$$\text{(B)} \qquad \nabla^2 u - \frac{\left(1 - \frac{\phi}{c^2}\right)^2}{c^2}\frac{\partial^2 u}{\partial t^2} = 0.$$

So that the velocity of a light quant in a gravitational field is $V = \frac{c}{1 - \frac{\phi}{c^2}} = c\left(1 + \frac{\phi}{c^2}\right)$, if $\frac{\phi}{c^2}$ is small, which is in agreement with the relativity equation for a Euclidean field. Applying the equation A to the electromagnetic field

$$E = E_0(x_1 y_1 z)e^{2\pi i\nu t}$$
$$H = H_0(x_1 y_1 z)e^{2\pi i\nu t}$$

it is shown that this field (light waves) consists of material waves of a light quant of mass $h\nu/c^2$. According to this view, optical phenomena fall into two classes: (1) those brought about by the light quant, *e.g.*, the Compton effect; (2) those due to its " material waves," *e.g.*, interference. J. E.

481.. Investigations in Connection with the Theory of Light Quanta. T. Takeuchi. *Zeits. f. Phys.* 50. 9–10. *pp.* 697–700, 1928.

The refractive index of a medium in a gravitational field, the number of light particles in the unit of volume, Brewster's law and the super-dispersion of the curved universe are investigated by simple calculations applying Schrödinger's wave equations for the motion of the electrons to the theory of light quanta. H. N. A.

482. Aurora and its Spectrum. J. C. McLennan. *Roy. Soc., Proc.* 120. *pp.* 327–357, *Sept.* 1, 1928.

The polar aurora is described and an account given of observations of its spectrum. The non-polar aurora or night-sky spectrum is then described in relation to the band spectrum of nitrogen. The conditions for exciting the 5577 Å. line in the spectrum of atomic oxygen are then described, together with its identification with the auroral green line. The position of the green line in the term scheme of oxygen is fully discussed and an account given of investigations on electronic transition by means of the Zeeman effect. Finally, an account is given of investigations of daily variations of intensity of this line, from which a maximum intensity is found between one and two a.m. F. S.

483. Theoretical Quantum Interpretation of the Auroral Green Line on the Basis of Interferometer Measurements of the Zeeman Effect. L. A. Sommer. *Zeits. f. Phys.* 51. 7–8. *pp.* 451–470, 1928.

With a Fabry-Perot interferometer the magnetic scattering of the green auroral line $\lambda = 5577 \cdot 350 \pm 0 \cdot 005$ is investigated and measured. This is found to yield a normal magnetic separation. On the basis of these observations the line is arranged in the system of the arc spectrum of neutral oxygen atoms. It is indicated as a combination $2^1D_2 - 2^1S_0$, where $^1D_2$ and $^1S_0$ are the deep-seated metastable terms. The line is thereby indicated as a transition with small separation and in general with less probability of transition of theoretical quanta in a similar way than for the nebula lines recently analysed by Bowen. The details of their occurrence in auroral light and in radiation from the night sky are thus understandable. By analysis of the terms $^1D_2$ and $^1S_0$ the existence of a singular system in the nitrogen system is demonstrated. The interpretation of the green line is rendered possible from the presence of red and violet oxygen radiation in the aurora and from the night sky which have an origin similar to that of the green auroral line (transition between deep-seated metastable terms). R. S. R.

484. Electronic States and Band Spectrum Structure in Diatomic Molecules. Part VII. $^2P \rightarrow {}^2S$ and $^2S \rightarrow {}^2P$. R. S. Mulliken. *Phys. Rev.* 32. *pp.* 388–416, *Sept.*, 1928.

A survey is made of the different empirical structure-types to be expected for $^2P \rightarrow {}^2S$ and $^2S \rightarrow {}^2P$ bands, and examples are discussed individually. The arrangement of the rotational levels in the ^2P state changes continuously with the parameter $\Delta E/B$ (ΔE = electronic doublet separation, B = coefficient of the main rotational energy term). In tables are given the changes of the ^2P levels with $\Delta E/B$, and data on ΔE and B for a number of molecules. A consistent notation, proposed in Part VI [see Abstract 908 (1928)], is given for the known branches of the MgH, CaH, OH, MnH, CdH, HgH and NO bands. In the MgH, CaH and OH bands band structure and missing lines show good agreement with theory. These bands are discussed in detail, and the observed relations appear to be in good agreement with the intensity formulæ of Hill and van Vleck. Various predictions are made. **Errata** (*ibid., p.* 997, *Dec.*, 1928). A. C. M.

485. Continuous Spectrum of Hydrogen. F. H. Newman. *Phil. Mag.* 5. *pp.* 807–811, *Nov.*, 1928. *Supplement.*

Describes a method of obtaining this continuous spectrum, which is different from the methods given by Crew and Hulbert [see Abstract 1023 (1927)]. An electric arc is passed between cold iron electrodes in a rarified hydrogen atmosphere, the arc being struck by means of an intermittent discharge between one of these electrodes and a third one enclosed in the discharge tube. No iron lines are obtained when the time of duration of the arc is short, as the electrodes do not heat up sufficiently. The radiation emitted is pale blue or whitish, and only a few Balmer lines appear in the spectrograms. If the hydrogen is not thoroughly dry the continuous spectrum is destroyed and the water bands appear. The limit of the continuous spectrum on the red side is approximately 4690 Å., it being shown that this is also approximately the theoretical limit of the Balmer series. The cause of the continuous spectrum may not be due to the interaction of an electron with the nucleus of a free atom; the atom could be influenced directly by other atoms or ions, the effect of water vapour on the continuous spectrum supporting this possibility. R. C. F.

486. Fulcher Spectrum of Hydrogen. E. Hiedemann. *Zeits. f. Phys.* 50. 9–10. *pp.* 618–625, 1928.

A discussion in some detail of the results of the author and other investigators, from which it is concluded that the Fulcher spectrum is due to the H_2 molecule and not to the H_3 molecule. The difference between the Fulcher spectrum and the line spectrum of hydrogen is due to the fact that the former is produced by a lower excitation collision of the H_2 molecule than is the latter. Further, the hydrogen continuous spectrum is emitted not by the change of the H_2^+ ion, but by the excited hydrogen molecules. R. C. F.

487. Spectrum of the Iron Arc under Reduced Pressure. P. Maring. *Zeits. f. wiss. Phot.* 26. *pp.* 47–85, *Oct.*, 1928.

Previously published data for the vacuum shift of the iron lines has related to the region 4000–6000 Å. In this paper the vacuum shifts for the lines in the region 2370–4000 Å. are obtained by measurement of the iron arc spectrum, both in air and under a pressure of only 10–12 mm. of mercury. The results for groups, such as the lines of the pressure groups of Gale and Adams, and the "normal" groups, are discussed, whilst the results for the multiplet lines are carefully examined. R. C. F.

488. Argon Spark Spectrum. T. L. de Bruin. *Zeits. f. Phys.* 51. 1–2. *pp.* 108–113, 1928.

Continues the analysis of this spectrum [see Abstract 1915 (1928)]. A bright spectrum was produced using a Geissler tube with a pressure of about 2 cm.; various new lines have been found. The level scheme previously determined with the deepest quartet terms has been completed by the addition of further doublet and quartet terms. 46 levels have been identified out of the 59 $3p$, $3d$, $4s$, $4p$, $5s$, $4d$, and ^{3}P levels, which are theoretically to be expected. From the term values the ionisation voltage of the ArII spectrum is found to be $27 \cdot 75 \pm 0 \cdot 05$ volts. Between λ5100 and λ3100 180 lines are classified. Tables of the terms and of the classified lines are included, together with a diagram showing the relation between the energy levels and one showing a portion of the spectrum in which the position of a number of multiplets is indicated. H. N. A.

489. Zeeman Effect of the Argon Spark Spectrum (ArII).

C. J. Bakker, T. L. de Bruin and P. Zeeman. *Zeits. f. Phys.* 51. 1–2. *pp.* 114–135, 1928.

The Zeeman effect of 110 ArII lines has been investigated, and the results are tabulated. It was necessary, in order to resolve very close Zeeman lines, to keep the temperature of the grating used constant to at least 0·05° during the time of exposure of a photographic plate, and the temperature of the observation room was regulated automatically. The analysis of the ArII spectrum carried out by de Bruin [see Abstract 1915 (1928) and preceding Abstract] was tested with reference to the Zeeman effect. It is shown from the measurements that normal and also anomalous couplings occur in the spectrum of ionised argon, and this is of great interest, since on theoretical grounds deviations in the Landé g factors are to be expected, owing to the fact that the atomic trunk has four $3p$ electrons. Definite groups of g values—those which depend on the same electron and the same inner quantum number—should, according to the theory of Heisenberg, Pauli and Landé, have constant g sums. This is confirmed for the terms of the $4s$ electrons, for which the g values are normal, and for those of the $4p$ electron and the $5s$ electron, for which they are anomalous; for the $3d$ and $4d$ terms the data are not sufficient to decide the point. The $^4F_5$ term is the only one found with $j = 5$, and according to the g sum law normal g values are to be expected for this term, which agrees with experience. H. N. A.

490. Spark Spectrum of Neon.

A. S. Ganesan. *Phys. Rev.* 32. *pp.* 580–582, *Oct.*, 1928.

A list of lines in the spark spectrum of neon between λ2300 and λ1850 is given. Many of the lines seem to belong to NeIII. AUTHOR.

491. First Spark Spectrum of Krypton.

P. K. Kichlu. *Roy. Soc., Proc.* 120. *pp.* 643–649, *Oct.* 1, 1928.

This paper is an analysis of the spark spectrum of krypton, made from published data [see Abstract 1295 (1928)]. The electronic configurations of Kr^+ with corresponding theoretical terms are first dealt with, it being shown that the doublet P-terms obtained from $5N_2$ and $4N_2O_2$ form a Rydberg sequence, from which the calculated fundamental $^2P_2$ term is found to be approximately 214,000. Azimuthal quantum numbers are also assigned, but these require confirmation in certain cases from Zeeman effect data. Certain typical multiplets are given, arising from the terms previously considered, but the table is not complete. All the lines considered in the present analysis, which ranges from 783·72 to 6768 Å., are tabulated, together with the intensities, wave numbers *in vacuo* and combinations. Considering only the first two numbers of the Rydberg sequence, the ionisation potential of Kr^+ is found to be 26·4 volts, this, however, being only an approximate value. R. C. F.

492. Spark Spectra of Selenium and Tellurium. L. and E. Bloch. *Comptes Rendus*, 187. *pp.* 562–564, *Oct.* 1, 1928.

Lines belonging to various degrees of excitation have been identified in an oscillating discharge in an electrodeless tube. Tables of observed wave-lengths in the regions 3400 Å. to 2200 Å. are given for SeIV, TeII, TeIII and TeIV. F. S.

493. The 29– and 30–Electron-System Spectra of Arsenic and Selenium. R. A. Sawyer and C. J. Humphreys. *Phys. Rev.* 32. *pp.* 583–592, *Oct.*, 1928.

New vacuum-spark data in the extreme ultra-violet have been obtained for arsenic and selenium. By aid of previous classifications in the 29– and 30–electron-system spectra of copper, zinc, gallium and germanium, it has been possible by extrapolation of the Moseley diagram, the irregular doublet law, screening constant data and the triplet interval ratios to predict the location of and to identify the lines arising from transitions between the lowest levels in the spectra of AsIV, AsV, SeV and SeVI. The ionisation potential of AsV is determined as 62·4 volts, that of SeIV as 81·4 volts. The $(4P^2)^3P$ separation of the 30–electron-system spectra is observed to show a rapid increase with respect to the separation both of the $(4s4p)^3P$ term and the $(4p)^2P$ term of the next ion. The theoretical significance of this effect, which is observed here for the first time, and which does not appear in the corresponding iso-electronic spectra of the lighter elements, is discussed. The effect is believed to be due to a change of coupling of the quantum vectors with increasing nuclear charge. AUTHORS.

494. Band Spectra in the Extreme Ultra-Violet excited by Active Nitrogen. H. P. Knauss. *Phys. Rev.* 32. *pp.* 417–426, *Sept.*, 1928.

The excitation of spectra of gases by the chemical activity of the "afterglow" of nitrogen is supposed to be due to the energy available when nitrogen atoms recombine to form molecules. In order to check this it is necessary to compare the heat of dissociation of nitrogen (11·4 volts) with the energy-levels found to be excited by the afterglow. The present investigation seeks to do this by the examination of spectra of gases excited in this manner in the region 2500–1000 Å.U., using a vacuum-grating spectrograph. In addition to the $\beta + \gamma$ bands of NO, bands called here δ were found belonging to another system with the same final levels (normal electronic state of the molecule). The zero δ-band is at 1915·7 Å., corresponding to 6·44 volts. Bands belonging to the fourth positive group of CO were also obtained, involving energies of from 8·2 to 9·0 volts. It is concluded that since energies up to 9 or 10 volts only are involved, the excitation is caused by a nitrogen molecule in one of a series of metastable states. This supports the view that atoms of nitrogen may continue to form an excited molecule responsible first for the emission of α bands and later for the excitation of other spectra. A. C. M.

495. Beryllium Hydride Band Spectra. W. W. Watson. *Phys. Rev.* 32. *pp.* 600–606, *Oct.*, 1928.

Two new band systems appear in a Be arc in hydrogen, one in the green from 4800 Å. to 5120 Å., the other from 3700 Å. to beyond 2200 Å. in the ultra-violet. Measurements of the bands of both systems at high dispersion are reported, and the quantum analysis is given. The green band group belongs probably to the $^2P \rightarrow {}^2S$ class due to BeH molecules. It consists of the 0–0, 1–1, 2–2, etc., bands, degrading to the violet, but all branches exhibit a marked shift to the red for $j > 30$. The analysis gives $I_0' = 2 \cdot 6833 \times 10^{-40}$ gm. cm.^{2} and $I_0'' = 2 \cdot 7212 \times 10^{-40}$ gm. cm.^{2} for the moments of inertia, $r_0'' = 1 \cdot 35 \times 10^{-8}$ cm., $\omega_0' = 2053 \cdot 4$, $\omega_0'' = 2025 \cdot 7$. The ultra-violet system consists of singlet P, R branch bands degrading to the red, the equation for the zero-points being $\nu = 39059 + 1460 \cdot 5n' - 14 \cdot 5n'^2 - 2182 \cdot 0n'' + 41 \cdot 0n''^2$. For this system, $I_0' = 3 \cdot 85 \times 10^{-40}$ gm. cm.^{2} and $I_0'' = 2 \cdot 50 \times 10^{-40}$ gm. cm.^{2}, $r_0'' = 1 \cdot 29 \times 10^{-8}$ cm. A discussion of the probable electronic transition for the ultra-violet bands is included. AUTHOR.

496. The Less Refrangible Bands in the Spectrum of Tin Monochloride. W. F. C. Ferguson. *Phys. Rev.* 32. *pp.* 607–610, *Oct.*, 1928.

Four groups of bands previously obtained by Jevons in a discharge through $SnCl_4$ vapour [see Abstract 1351 (1926)] are now found also in streaming active nitrogen. Two groups, α and β, were previously classified as a $^2S \rightarrow {}^2P$ transition in SnCl; with the help of new measurements, and from an examination of the band structure, it is concluded that the other two groups, λ3500 and λ3800, are a $^2D \rightarrow {}^2P$ transition with the same ^2P state as the α and β bands. The chlorine isotope effect confirms the identity of the emitter as SnCl and confirms the vibrational quantum number assignments. The vibrational intensity distribution (intensity concentrated in $\Delta n = 0$ sequence) is in qualitative agreement with theory, for the ratio of ω_0'' to ω_0'. An attempt was made to obtain analogous bands by introducing SnI_4 vapour into active nitrogen, but no new bands were obtained. AUTHOR.

497. Luminescence of Solid Nitrogen under Kathode-Ray Bombardment. J. C. McLennan, H. J. C. Ireton and E. W. Samson. *Roy. Soc., Proc.* 120. *pp.* 303–311, *Sept.*, 1, 1928.

High-velocity electrons from a Coolidge-type tube were used. In addition to the well-known bands N_1, N_2 and N_4 several bands were found in the red and infra-red. One with its maximum at 6400 (probably that recorded by Vegard as N_3) was found with long exposures. A strong infra band occurred at 8535, a red band at 6725, and a faint narrow band at 6187. In the region of shorter wave-lengths there are found two series of bands with nearly constant wave-number differences. The bands N_1, N_2, N_4 are all phosphorescent ones, N_2 and N_4 being in the persistent state at the temperature of liquid hydrogen, while N_1 was in the lower instantaneous state, appearing as thermoluminescence at a little higher temperature. There was no marked polarisation of the visible bands. The rate of decay of the N_2, N_4 bands was measured. The phosphorescence belongs to the vanishing type. There are two distinct stages in the decay of N_4, three in N_2. Each stage fitted an equation of the type $I = 1/(a + bt)^2$, where I is intensity, t is the time, and *a* and *b* are constants. If the phosphorescence is due to an active centre in a diluting medium, then the large frequency differences point to hydrogen as the active centre. J. E.

498. Time Function of the Light Radiations of Active Nitrogen. A. Koenig and G. H. Klinkmann. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 335–351, *Oct.*, 1928.

Examination of recent researches support the view of Strutt (Rayleigh) that the carrier of the luminescence of nitrogen during and after the electric discharge is a molecule, but that the luminescence is excited by the union of free atoms. This is in accord with Wien's determinations of the time during which the lines of hydrogen observed in canal rays streaming into a high vacuum remain luminescent, and with the photometric estimates of Angerer [see Abstract 918 (1921)] and Bródy of the duration of the afterglow of nitrogen. The authors force the nitrogen under pressure through a clay filter (a thimble) into and through a solution of sodium hydrosulphite; the very small bubbles become positively charged by streaming through the alkaline liquid, do not coalesce and are completely freed of any traces of oxygen and carbon dioxide. The nitrogen, further purified and dried, passes into the discharge bulb and through a vertical quartz tube, 5 mm. in diameter. A series of four spectrograms is taken with the aid of a Koch microphotometer, each with an exposure of about 8 minutes; wave-lengths are determined by comparison with the spectra of helium and of the positive column of nitrogen. The integral luminescence of active nitrogen decreases in the manner of a bimolecular reaction. The bands 4310/4300 and 4040/4025 Å. of the β group do not appear to have equivalents in the arc spectrum. The bands fade in the descending order red to violet, the red twice as rapidly as the violet, and the α group more rapidly than the β group. The activity and afterglow do not run parallel. The colour of the afterglow changes with the fading from golden-yellow to greenish-grey; owing to a gas film on the quartz walls it is first bluish. H. B.

499. Spectrum of Doubly-Ionised Nitrogen (NIII). L. J. Freeman. *Roy. Soc., Proc.* 121. *pp.* 318–343, *Nov.* 1, 1928.

The spectrum of doubly-ionised nitrogen (NIII) has been further investigated over a range extending from the far red to the extreme ultra-violet, and some 170 previously unrecorded lines have been measured. In all, about 120 lines have been newly classified, 100 in the quartet system and 20 in the doublet system. AUTHOR.

500. Combined Action of Collision and Radiation. O. Oldenberg. *Zeits. f. Phys.* 51. 9–10. *pp.* 605–612, 1928.

The two continuous branches spreading out on either side of the mercury resonance line λ2537 when helium or neon is mixed with the mercury vapour are shown to be due to the combined effect of a collision and a normal quantum jump [see Abstract 1284 (1928)]. The suggestion that the continuous bands are in reality molecular spectra is ruled out by a consideration of (*a*) the effect of temperature, (*b*) the dissociation heat of the "molecule" HgHe which might be formed. The general relations of atomic processes involving kinetic energy, excitation energy and radiation are discussed. W. S. S.

501. Zeeman Effect for the Spectrum of Tantalum. J. C. McLennan and A. M. I. A. W. Durnford. *Roy. Soc., Proc.* 120. *pp.* 502–510, *Oct.* 1, 1928.

Zeeman patterns were measured for 55 tantalum lines between λ5548 and λ6700, the separations being tabulated in sections corresponding to different type patterns. Several of the Zeeman patterns confirm the result given by recent work on atomic states and spectral terms [see Abstract 50 (1927)], that the lowest spectral term for tantalum is $^4F_2$, indicating a quartet system for the arc spectrum. W. S. S.

502. Broadening of Spectral Lines by Auto-Absorption. H. C. Burger and P. C. van Cittert. *Zeits. f. Phys.* 51. 9–10. *pp.* 638–651, and 52. 3–4. *p.* 300, 1928.

The dispersion effect for temperatures which are not too low, and with materials of small molecular weight, chiefly affects the wings of a line, and does not markedly alter the half-value breadth. The authors confine their investigation to the case when this effect can be neglected in comparison to the thermal Doppler effect, and study mathematically the alteration in the distribution of intensity of a line due to absorption. Observations have been made on the stronger lines of helium, and the coefficient of absorption measured for the red line $2^1P - 3^1D$; it is found to be very large in agreement with theory. The explanation of the measurement of the width of the triplet lines is made difficult by their multiplet structure; by cooling the light source with liquid air an analysis of this structure has been made possible, the breadth of the lines being reduced to about one-hundredth part of the original. H. N. A.

503. Absorption Spectra of Crystals which contain Traces of Foreign Ions. I. Maslakowez. *Zeits. f. Phys.* 51. 9–10. *pp.* 696–706, 1928.

An extension of the work of Hilsch, Smakula, Pohl [see Abstracts 97 and 1920 (1928)]. Details and diagrams are given of the absorption spectra of thin films of pure KNO_3 and KNO_2, and of a number of alkali halide crystals into which traces of KNO_3 and KNO_2 have been fused. The ultra-violet and infra-red absorption bands of the NO_3 and NO_2 ions are very clearly exhibited by the adulterated crystals. If either NO_3 or NO_2 ion is added to the crystal, the absorption bands of both these ions appear. It appears that in general other foreign anions (CO_3, SO_4) cannot be built into the alkali halide crystal without severe structural derangement. H. R. R.

504. Light Absorption and Mode of Union between Molecules of Gases and Vapours. H. Sponer. *Zeits. f. Elektrochem.* 34. *pp.* 483–489; *Disc.*, 518–520, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

It is shown experimentally that the nature of the dissociation produced by light absorption furnishes reliable data for the determination of chemical union. Molecules such as H_2, O_2, and the halogens dissociate into normal and excited atoms designated as atomic molecules, since in the fundamental state of these compounds atoms oscillate towards each other. Compounds such as AgI, AgBr and AgCl also exhibit spectroscopically these atom-molecules, which must be divided into polar and non-polar classes. In the case of ionic molecules, dissociation gives not only normal and excited atoms, but also two normal atoms at the lowest dissociation stage, this being characteristic of the species. Franck's work [see Abstract 2722 (1927)] should be consulted. H. H. Ho.

505. Absorption Bands of the Halogens. P. Bovis. *Ann. de Physique*, 10. *pp.* 232–344, *Sept.–Oct.*, 1928.

In addition to preliminary observations of the absorption of aqueous solutions of copper sulphate, chloride and acetate, cobalt sulphate and chloride, nickel sulphate and chloride and potassium chromate, measurements have been made of the absorption of thin films of liquid bromine at temperatures between 5° and the boiling point, in comparison with the absorption of the vapour. In both states there is a violet band with maximum at 4210 Å.U., but the maximum is twice as great for the liquid as for the vapour. The absorption of the vapour is negligible between 3400 and 2500 Å.U., and only begins to show again at still shorter wave-lengths, whereas liquid bromine is absorbent throughout this range. The effect of temperature is as if the thermal expansion were seven times as great as it is actually. In addition to the violet band, solutions of bromine in water, chloroform, carbon tetrachloride, carbon disulphide, and alcohol give an ultra-violet band at about 2600 Å.U. The displacement of these bands towards the red does not vary in the same sense as the maximum extinction coefficient. The band observed by Liveing and Dewar in carbon tetrachloride is due to traces of carbon disulphide. Solid iodine gives a band at 2550 Å.U., which may correspond to the band near 2060 Å.U. in the vapour. T. M. L.

506. Absorption Band Spectrum of Iodine Monochloride. E. D. Wilson. *Phys. Rev.* 32. *pp.* 611–617, *Oct.*, 1928.

The visible absorption spectrum of ICl has been photographed and measured. Eight new members have been located in the two series described by Gibson and Ramsperger as corresponding to $n'' = 1$ and $n'' = 2$. The limit of convergence of the former series is at $\nu = 17{,}430 \pm 5$ cm.$^{-1}$, which makes the heat of dissociation equal to $49{,}650 \pm 15$ calories per mol. Four members of a new series for which $n'' = 3$ have been found, so that it has been possible to compute the fundamental vibratory frequency of the molecule as 381·9 cm.$^{-1}$. Still another series of five members is recorded, whose presence may be due to the existence of a close electronic doublet having a separation of about 36 cm.$^{-1}$. The ratio of the two specific heats of gaseous ICl has been calculated to be 1·30, in agreement with empirical results. The fine structure of three consecutive bands has been measured, and the corresponding values of the parabolic parameter C have been computed to be in agreement with the theory of the change of the moment of inertia I, with ω, the frequency of vibration of the molecule. By combining both sets of data for band heads and fine structure, the following approximate values for the moment of inertia have been computed: $I'' = 575 \pm 100 \times 10^{-40}$ g. cm.^{2}; $I' = 995 \pm 200 \times 10^{-40}$ g. cm.^{2} AUTHOR.

507. Absorption Spectrum of Liquid Benzene. J. Barnes and W. H. Fulweiler. *Phys. Rev.* 32. *pp.* 618–623, *Oct.*, 1928.

A precision method is described for measuring the wave-lengths of radiation in the near infra-red region of the spectrum using a 6-ft. Rowland concave grating with a Thalofide cell. The results obtained are believed to be accurate within $0{\cdot}001\,\mu$. With this method the wavelength of an outstanding absorption band of liquid benzene was determined. The frequency of this band, together with the frequencies of other bands previously measured by the authors, substantiates the theory that the absorber of these radiations is a linear anharmonic oscillator, whose energy states are represented by odd multiples of half-quanta. AUTHORS.

508. Absorption Spectrum of Cæsium. Irene M. Mathews. *Roy. Soc., Proc.* 120. *pp.* 650–654, *Oct.* 1, 1928.

Values for the principal series in the absorption spectrum of cæsium are obtained from spectrograms of the light from the carbon arc after passing through a steel tube in which the cæsium vapour was prepared by heating pure dried cæsium carbonate in the presence of powdered magnesium. Beyond $m = 8$ the doublets showed single lines only, whilst the series could not be traced beyond $m = 32$. The observed values of the P_2 lines agree quite well with the values calculated from Hick's formula, thus showing that for the s and p terms this formula is reasonably correct. R. C. F.

509. Polarisation of the Resonance Radiation from Degenerate Systems. F. C. Hoyt. *Phys. Rev.* 32. *pp.* 377–387, *Sept.*, 1928.

The problem of resonance between light and an atom is treated by solving the wave equation through the method of variation of constants. It is found that an initial degeneracy is removed by the action of the light, and that there occur fluctuations between the two states involved. Calculation of the electric moment of the perturbed atom on the Schrödinger density hypothesis shows that when the incident light is linearly polarised the radiation has the same degree of polarisation as though the atom were in a weak magnetic field parallel to the electric vector of the light. In the case of circular polarisation this fictitious field is perpendicular to the plane of polarisation. These results confirm the Heisenberg rule deduced from the correspondence principle. AUTHOR.

510. Polarisation of Resonance Radiation in Mercury. H. F. Olson. *Phys. Rev.* 32. *pp.* 443–446, *Sept.*, 1928.

$1^1S_0 - 2^3P_1$ of mercury excited by plane polarised light shows incomplete polarisation both in the absence and in the presence of a weak field parallel to the electric vector. The amount of initial polarisation depends upon the relative intensities of the hyperfine structure lines in the exciting light. The polarisation with various relative orientations of field and light vector and the variation of polarisation with field intensity in weak fields may be interpreted successfully by means of a semi-classical model, with proper relative intensities parallel and perpendicular to the light vector, rotating after excitation with an angular velocity $geH/2mc$ and emitting a damped wave. From curves connecting depolarisation, rotation of maximum of polarisation, etc., with field intensity α, the damping constant, has been found to be $1{\cdot}02(\pm\,0{\cdot}02)10^7$ sec.$^{-1}$. AUTHOR.

511. Intensities of the Lines in the Spectrum of Mercury. E. O. Hulbert. *Phys. Rev.* 32. *pp.* 593–599, *Oct.*, 1928.

The total radiation, measured with a thermocouple, in the spectral region 6000 to 2300 Å. from a small quartz mercury lamp of known size filled with mercury vapour at a known pressure was $1 \cdot 85 \times 10^{-10}$ erg per atom per sec. From this and the intensities of the lines it came out that each atom on the average emitted each second 11·4, 8·9, 5·0, 2·3, etc., quanta of yellow, green, blue, violet, etc., light respectively. The intensities of twenty-four lines of the spectrum were measured with a quartz spectrograph, a thermocouple and a photoelectric cell, all calibrated, and in some cases with a photographic densitometer. Plotting the logarithm of the intensity against the frequency for the lines of a series gave roughly straight lines of about the same slope for the sharp series ($2^3P_n - m_3S_1$) and for the diffuse series ($2^3P_n - m^3D_{123}$). The temperatures of the excited atoms derived from the slopes were 3900° and 2600° Kelvin for the sharp and diffuse series respectively. AUTHOR.

512. Raman Effect in Aqueous Solutions. A. Carrelli, P. Pringsheim and B. Rosen. *Zeits. f. Phys.* 51. 7–8. *pp.* 511–519, 1928.

The Raman spectra of pure water and solutions of HNO_3, $NaNO_3$, $NaNO_2$, NH_4NO_3 and NH_3 excited by the Hg arc were photographed and the relation between their frequency differences and the infra-red frequencies are discussed. It is shown that otherwise inactive vibration frequencies come into play in the Raman effect. Photographs of NaCl and HCl showed no displaced lines, probably owing to the complete dissociation and consequent absence of molecular groups with characteristic vibration frequencies. The degree of polarisation of the individual lines was examined; this is not uniform, showing that the different lines are due to different parts of the molecule. J. E.

513. Raman Spectra of Scattered Radiation. R. W. Wood. *Phil. Mag.* 6. *pp.* 729–743, *Oct.*, 1928. *Comm. No.* 7 *from the Loomis Lab., Tuxedo.*

Raman and Krishnan have found that if various transparent media, such as fluid organic compounds, crystals, and even water, are illuminated with monochromatic light, the spectrum of the light scattered by the medium shows, in addition to the line of the illuminating radiation, other bright lines the wave-lengths of which depend upon the nature of the medium. This phenomenon appears to be quite different from fluorescence and opens up a new field in the study of molecular structure. The present paper describes in detail a greatly improved apparatus whereby the strongest Raman lines can be photographed with an exposure of a few minutes, and comprehensive experimental results are given for carbon tetrachloride, chloroform, benzene, toluene, monochlorobenzene, quartz and calcite. Full sets of values have been included to demonstrate not only the complete verification of Raman's theory, but also the value of the method for the investigation of the remote infra-red absorption region by the study of modified lines in the visible part of the spectrum. H. H. Ho.

514. Thermal Measurement of X-Ray Energy. J. A. Crowther and W. N. Bond. *Phil. Mag.* 6. *pp.* 401–422, *Sept.*, 1928.

The energy of a beam of X-rays was measured by converting it into heat in a calorimeter, and it is concluded that over the range of wave-lengths used the energy absorbed from the radiation for the formation of one pair of ions in air is 42·5 "volts." The quantity of electricity I measured in electrostatic units across 1 c.c. of air at 18° C.

and normal pressure is given by $I = 1 \cdot 70 \,.\, 10^{-4}\, E\tau$, where E is the total X-ray energy in ergs which has passed through the gas, and τ is the "true" mass coefficient of absorption. The relation cannot be applied to a heterogeneous radiation owing to the impossibility of determining τ for such radiation. The results obtained by other workers are carefully discussed. W. H. GE.

515. Recombination of Ions in the Chamber of an X-Ray Spectrometer. D. L. Webster and R. M. Yeatman. *J.O.S.A. and R.S.I.* 17. *pp.* 254–259, *Sept.*, 1928.

It is usually assumed that for accurate comparisons of X-ray intensities the voltage applied to the ionisation chamber must be sufficient to reduce the loss of ions by recombination to a fraction of the total number produced, less than the permissible error of measurement. Tests show, however, that under proper conditions the fraction lost may be independent of the total number produced, for any loss up to about 10 %. With the chamber used here, this permits accurate comparisons of ionisation currents with only 45 volts, instead of the 900 required to reduce the loss to 1 %, and thereby minimises errors due to battery changes. This constancy of the fraction lost, with different currents, probably indicates that the recombination is practically all columnar, as reported by other observers with α-rays. In the case of X-rays, columnar recombination must be recombination between ions produced by the same photoelectron. This condition must be satisfied best with faint rays, such as are used in X-ray spectrometry. With stronger rays it should break down, and therefore these tests do not indicate anything about ordinary X-ray dosage measurement. AUTHORS.

516. Fine Structure of Scattered Radiation from Graphite. B. Davis and D. P. Mitchell. *Phys. Rev.* 32. *pp.* 331–335, *Sept.*, 1928.

This analysis of the "undisplaced" scattered radiation was made with the double X-ray spectrometer previously described [see Abstracts 1298 and 1299 (1928)]. A special double target (Mo) X-ray tube was used with a block of graphite between the targets as the scattering element. The crystals were placed for reflection at first order. Four lines were observed: (*a*) an undisplaced line at position of MoKα_1; (*b*) a line displaced 80″ (0·0012 Å.) from Kα_1 position; (*c*) a line displaced 140″(0·002 Å.) from Kα_1; (*d*) a line displaced 780″ (0·0113 Å.) from Kα_1. These are all on the long wave-length side of MoKα_1. The undisplaced line (*a*) is scattered from the whole atom. The line displaced (0·0113 Å.) closely agrees with $h\nu' = h\nu - Ve$, where Ve is the energy level (287 volts) of the carbon atom. The line (*b*) is displaced (0·0012 Å.). This is equivalent to 29 volts, which does not agree with the L_{111} level of carbon (11·2 volts). The line (*c*) is displaced (0·002 Å.). This is equivalent to 50 volts, and does not agree with the L_1 level of carbon, which is 34 volts. In the case of these two lines the relation $h\nu' = h\nu - Ve$ does not hold. A search was made for scattered radiation on the short wave-length side of the MoKα_1 position, corresponding to the relation $h\nu' = h\nu + Ve$. No positive results were obtained. [See next Abstract.] AUTHORS.

517. Effect of Chemical Combination on the Structure of the K Absorption Limit. B. Davis and H. Purks. *Phys. Rev.* 32. *pp.* 336–338, *Sept.*, 1928.

The structure of the K absorption limits of some chemical compounds was examined with the double X-ray spectrometer. This instrument has been previously described [see Abstracts 1298 and 1299 (1928)]. The K absorption limits of the elements Ag, Mo and Cu and the compounds Ag_2S, Ag_2O, also MoO_3, MoS_2 and Mo_2O_3 were examined for increase in width or fine structure. The width for the pure element decreases with increasing atomic number. The general effect of the chemical action was to broaden the absorption limit, but there was little displacement. In one case, M_2O_3, there was evidence of fine structure. The silver salts appeared to be considerably reduced by the X-rays. Recent experiments of H. S. Read [see Abstract 708 (1927)] indicate an increase of absorption due to temperature of the absorbing element. Also the results were interpreted as due to a shift in the absorption limit. This matter was examined with the double spectrometer. A strip of Mo was heated to incandescence in vacuum. The position and form of the K limit was compared to that for cold strip. They were identical. No effect of temperature was detectable. This method would probably detect one-tenth the displacement estimated by Read. AUTHORS.

518. Action of X-Rays on Colloidal Ceric Hydroxide. J. A. V. Fairbrother. *Phil. Mag.* 6. *pp.* 385–401, *Sept.*, 1928.

As a result of a quantitative study of the viscosity changes produced in ceric hydroxide hydrosol by X-rays, it is found that in sols of low concentration and with increasing X-ray doses the viscosity decreases to a minimum, then increases rapidly, and the sol sets to a rigid gel. In more concentrated sols the spontaneous increase in viscosity which takes place when the particles are discharged masks the initial decrease. The sols become more sensitive to X-rays with age. When the position of minimum viscosity is reached the sol sets spontaneously to a rigid gel within a few hours. An X-ray dose sufficiently in excess of that required to produce the maximum decrease will set the sol to a gel immediately. In a particular sol studied the particles decreased in size up to the position of minimum viscosity. The percentage decrease in size was almost equal to that in viscosity. Beyond the minimum point the particles increase in size, reaching a maximum at the setting point of 1·6 times the normal value. W. H. GE.

519. Röntgen Absorption Spectra and Chemical Union. O. Stelling. *Zeits. f. Elektrochem.* 34. *pp.* 520–522, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

The author continues the work of Bergengren [see Abstract 875 (1921)] and Lindh [see Abstract 1398 (1925)], and confirms their hypotheses that a definite connection exists between the K-Röntgen absorption spectra and the chemical constitution of the compounds investigated. The systematic investigations recorded and discussed deal principally with the elements phosphorus, sulphur, chlorine and potassium. It is found that compounds which contain the absorbing atom in one and the same radicle give the same absorption spectra. Variations, however, occur when, for example, an oxygen atom in a sulphate radicle is replaced by an organic group, and also when the number as well as the species of absorbing atom changes. Different metallic atoms in the sulphides and chlorides exert different effects on the positions of the sulphur and chlorine absorptions, and these are shown to be due to the deforming influence of kation upon anion. A series of complex chlorine compounds has been studied to ascertain whether by means of Röntgen absorption spectra a discrimination can be made between the different types of union, and positive results are claimed. From a study of the aldehyde and ketone bisulphite compounds the conclusion is drawn that there are oxysulphonic acids. Further work is promised. H. H. Ho.

520. Action of Röntgen Rays on Chloroform and Similar Compounds. P. Günther, H. D. v. der Horst and G. Cronheim. *Zeits. f. Elektrochem.* 34. *pp.* 616–625, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May,* 1928.

Reference is made to the quantitative work of Glocker and Risse [see Abstract 2730 (1928)], who showed the action to be due to liberated secondary electrons. In agreement with them it is found that the hard components of the rays have the greatest chemical activity. The present work indicates that Röntgen rays liberate hydrogen chloride from chloroform in quantities directly proportional to the energy of the rays. Dampness increases the yield of hydrogen chloride. From pure carbon tetrachloride a very small yield of chlorine is obtained and in the presence of water vapour also acid. Qualitative investigations are also described for mixtures of chloroform and carbon tetrachloride as well as for ligroin and hexahydrobenzene. J. K.

521. Relation between Chemical Constitution and X-Ray K Absorption Spectra. Part VII. General Review of the Results Obtained. O. Stelling. *Zeits. f. Phys.* 50. 7–8. *pp.* 506–530, 1928.

Describes briefly the method employed, and discusses the methods of measurement used by different investigators; gives an account of the results obtained on the displacements of the K absorption edges of phosphorus, sulphur and chlorine in a number of chemical compounds, and discusses them theoretically. Deals with the theoretical considerations brought forward by Aoyama, Kimura and Nishina in opposition to the author's views. Studies the relation between the shifts of the absorption edges and the variations of the distance between ions, the lattice type and the electronic configuration of the kations. The shift appears to be due to deformation of the negative ions by the surrounding positive ions; deformation in general makes the absorption edge of the negative ion "harder," it alters the work required to split off a K electron, and an increase in this work is to be expected. In homopolar compounds, where certain electronic orbits are common to the two nuclei, the new orbits which go round the positive central atom tend to loosen the bonds of its K electrons, and the K absorption edge becomes softer. The paper contains a mass of observational detail, which is considered in relation to the theory. H. N. A.

522. Alteration of X-Ray Absorption Spectra in Crystal Lattices. K. Fajans. *Zeits. f. Phys.* 50. 7–8. *pp.* 531–536, 1928.

Endeavours to find out whether the analogy observed by Stelling between the alterations in the wave-lengths of the X-ray absorption edges and those of the mol refraction of ions in crystal lattices can be extended to cover the quantitative relations. It appears that the shift of the absorption edges is universely proportional to the fourth power of the distance between the ions, which is the same law as that determined by the author for the changes of the mol refraction of an ion. Should this high inverse power of the distance be confirmed by measurements of increased accuracy it would indicate that the effect on the X-ray spectrum is to be ascribed to polarisation or deformation of the ion in the lattice. H. N. A.

523. Intensity of X-Ray Lines, especially of the K-Series of Aluminium, in Relation to the Tube Voltage. E. Lorenz. *Zeits. f. Phys.* 51. 1–2. *pp.* 71–94, 1928.

Measurements on intensity-voltage have so far given the result that at first the intensity is proportional to $(V - V_0)^2$, where V_0 is the excitation voltage. At higher voltages the rise is slower and approaches a maximum. This work is concerned with the intensity rise up to very high voltages. Preliminary work on the spectral intensity of the so-called "Stielstrahlung" showed that these possessed a short wave-length whose origin was accounted for by the secondary electrons from the focus spot. From the voltage difference of the shortest waves of the "Stielstrahlung" and the ordinary radiation could be deduced from which level of the tungsten atom the secondary electrons came. It was found that secondary emission for a definite level ceased when the voltage exceeded forty times the excitation value for that level. This conclusion was then tested with intensity measurements on the K-series of Al. The intensity rose up to twice the excitation voltage at the rate $I = (V - V_0)^2$; then followed a slower rise, reaching a maximum at eleven times the excitation voltage. At still higher voltages the intensity fell again. Extrapolation from the intensity curve obtained with a very thin anode showed that the intensity of the lines would become zero at forty times the excitation voltage. J. E.

524. K X-Ray Absorption Edge of Iron. G. A. Lindsay and H. R. Voorhees. *Phil. Mag.* 6. *pp.* 910–920, *Nov.*, 1928. *Supplement.*

It is shown that the multiple structure of the K absorption edge for iron, in the metallic state and in a number of compounds, extends over a range which is much greater than has been observed in any other element; in the case of metallic iron the structure is distinct to more than 300 volts from the principal edge, and there are less distinct indications for several hundred volts farther. The magnitude of this range can best be explained by assuming ejection of electrons from the outer orbits simultaneously with the K electron. Kossel's hypothesis is considered as being only satisfactory as a possible explanation of the white line absorption. The principal edge shifts to shorter wave-lengths as the valency increases, but the effect of valency on the multiple structure is small. When compounds containing bivalent and trivalent iron were mixed and employed in the absorbing screen superposition of the two patterns produced by the two valencies could be observed, but when the two valencies were in the same chemical compound, as in lepidomelane, no overlapping was found.

H. N. A.

525. Generalised Scattering Formula. I. Waller. *Zeits. f. Phys.* 51. 3–4. *pp.* 213–231, 1928.

Develops a formula, which is approximately correct for short wavelengths, for the scattering of radiation by an atom system. Wave mechanics methods are used, but Schrödinger's method for the calculation of the radiation of an atom system is particularly considered. The method can be used, not only for atoms with several electrons, but also for molecules with several atoms. Use of the formula for the treatment of the problems of the scattering of Röntgen rays by a crystal, considering the heat oscillations, is also given. R. C. F.

526. Direction of Ejection of Photoelectrons by Polarised X-Rays. C. J. Pietenpol. *Phys. Rev.* 32. *pp.* 564–569, *Oct.*, 1928.

The lateral distribution of the electrons ejected from air at low pressures was investigated, using Geiger counters which could rotate about the primary polarised beam. The results are in better accord with Auger and Perrin's cosine squared relation than with Bubb's theoretical curve, although owing to incomplete polarisation and other causes the agreement is not perfect. W. S. S.

527. Theory of X-Ray Diffraction in Liquids. G. W. Stewart. *Phys. Rev.* 32. *pp.* 558–563, *Oct.*, 1928.

A critical review is given of the theories of X-ray diffraction in liquids advanced by Raman and Ramanathan, and Zernike and Prins. It is pointed out that the Ehrenfest scattering formula is inapplicable to liquids. The theory of " cybotaxis," which assumes instantaneous molecular groupings in the liquid, coupled with the crystal powder theory, is regarded as explaining the phenomena found in the most simple way.
W. S. S.

RADIOACTIVITY.

528. Constancy of Action of Radioactive Preparations. H. J. Vogler. *Phys. Zeits.* 29. *pp.* 678–681, *Sept.* 15, 1928.

The observations were made between April and November in a room which was kept constantly dark, a Benndorf electrometer being employed and a Bergwitz ionium preparation. The ionisation chamber could be enclosed in cardboard, and the joints of the box closed airtight with beeswax. Observations were made by the self-registering instrument every hour of the twenty-four during long periods, and at the same time the conductivity of the air, the barometric height, the temperature, and the humidity of the air were recorded. When the cardboard box was not employed there were considerable variations in the electrometer readings, but when the box was used these became very small indeed. The variations seem to be connected with those of the air conductivity.
H. N. A.

529. Existence of Aggregates of Active Deposit Atoms in Gases containing Radon. E. L. Harrington. *Phil. Mag.* 6. *pp.* 685–695, *Oct.*, 1928.

Experimental evidence is given of the existence of aggregates of atoms of active deposit in mixtures of radon and air, also of radon and argon, including in either case more or less water vapour. The evidence is both direct and indirect. Photographic evidence as to the nature and variety of these aggregates is included. Suggestions as to the possible origin of these aggregates seem to account for the facts experimentally obtained by various observers. AUTHOR.

530. Photographic Intensity Measurements of Polonium Preparations. Marietta Blau. *Akad. Wiss. Wien, Ber.* 137. 2*a*. 5–6. *pp.* 259–268, 1928.

A simple photographic method is described by the use of which reproducible values for the α-intensities of polonium preparations may be obtained. The ratios of the intensities of highly concentrated preparations of equal dimensions, found by the photographic method, agree to within 3 % with those determined from ionisation measurements. The results confirm the validity of the Bunsen-Roscoe law for blackening by α-particles. It is also found that, for equal exposure times, equal blackening values are obtained for continuous or intermittent exposure to α-radiation. The fact is discussed that no swelling value is shown by the blackening curves for all radiations for which the Bunsen-Roscoe law holds (α-, β- and X-rays), contrary to those for light rays. L. L. B.

531. Some Experiments on the Multiple Scattering of α-Particles. D. C. Rose. *Cambridge Phil. Soc., Proc.* 24. *pp.* 557–566, *Oct.*, 1928.

Describes experiments in which a small source of radioactive material was placed on a disc of metal, or very close to it, and photographs were taken near the plane of the disc, but at a distance from its centre, in the hope of recording in addition to the direct α-particles those which were scattered from the disc at glancing angles, and thus possibly increasing the effective strength of the source for a very narrow beam. No measurable effect was obtained. Some experiments of Lawson and Hess on the scattering of α-particles by the walls of a long glass tube were repeated. They found that the scattered particles lost definite amounts of energy; the author's experiments indicate that they can lose any fraction of their total energy. It appears that the most probable angle of scattering is large, and that the average particle spends at least half and probably a greater fraction of its range in the glass walls. H. N. A.

532. Quantum Theory of the Atomic Nucleus. G. Gamow. *Zeits. f. Phys.* 51. 3–4. *pp.* 204–212, 1928.

The Schrödinger wave equation is applied to the emission of α-particles by nuclei. The potential function is coulombian up to a certain point, attains a maximum and then falls again. It is characteristic of the Schrödinger theory that an α-particle nearer to the nucleus than the potential maximum, and having less kinetic energy than that corresponding to the potential maximum, will still have a certain probability of escape. This probability is worked out approximately, and shown to lead to a logarithmic relation between the disintegration constant and the energy of the expelled α-particle, as found experimentally for the radioactive elements. The order of magnitude of the constant in this expression is also in agreement with experiment. W. S. S.

533. Ranges of the Products of Artificial Atomic Disintegration. W. Bothe. *Zeits. f. Phys.* 51. 9–10. *pp.* 613–617, 1928.

It is shown that, when the disintegrating α-particle is held by the disintegrated atomic nucleus, it is possible to calculate the relation between the range of ejected H-particles in terms of that of the α-particles employed. In the case of nitrogen the formula deduced appears to hold; this appears to be in agreement with the observations by Blackett on this gas, using the Wilson cloud method; no α-particle tracks were observed after collision, and Blackett concluded that the α-particles were held by the disintegrated N nuclei. No such agreement between the above theory and observation is found for the other disintegrated elements.

H. N. A.

534. Number of Hydrogen Particles observed in Artificial Disintegration Experiments. G. Kirsch and H. Pettersson. *Zeits. f. Phys.* 51. 9–10. *pp.* 669–695, 1928.

New work on atomic disintegration by α-particles is discussed, with particular reference to the criticisms raised by Bothe and Fränz [see Abstracts 2938 (1927) and 2421 (1928)]. It is maintained that the discrepancies between the results of the Vienna school and those of Bothe and Fränz are attributable to (*a*) irregular action of the Geiger counter as a detector of H-particles and (*b*) possible contamination with hydrogen.

H. R. R.

535. Velocity Distribution of β-Particles after Passing through Thin Foils. P. White and G. Millington. *Roy. Soc., Proc.* 120. *pp.* 701–726, *Oct.* 1, 1928.

When a parallel beam of β-particles, homogeneous in velocity, falls upon a sheet of matter not thick enough to obstruct it completely, the stream which emerges consists of particles which in general have suffered both a loss of velocity and a change in direction of motion. The investigation of this action accordingly falls into two parts, one directed to examining the changes in direction of motion of the particles, or scattering of the beam, the other to measuring their loss of velocity. This paper is devoted to the second of these problems. The velocity distribution of β-rays ($H\rho 1410$ to 1938) which have passed through sheets of mica (2 to 6 mgm. per sq. cm.) has been found by photometry of a magnetic spectrum, and the results are expressed in terms of a fundamental straggling curve. The relation between the most probable loss of velocity and the thickness of the stopping material has been investigated for $H\rho 1410$ to 5904, and a surface density of 2 to 14 mgm. per sq. cm., and found to show a small systematic divergence from Bohr's theory which is beyond the limits of experimental error. The same has been obtained of the relation between the initial velocity and the most probable loss of velocity.

A. B. W.

536. Ionisation Measurements of γ-Rays. J. A. Chalmers. *Phil. Mag.* 6. *pp.* 749–762, *Nov.*, 1928.

Ionisation is only dependent on the primary γ-rays through the agency of the secondary β-rays produced by them, and may not measure any definite property of the γ-ray beam. It is shown that striking alterations take place in the relative ionisation produced by RaB and RaC γ-rays when aluminium is replaced by lead in the whole or in part of the ionisation chamber; the base, walls and top were altered in turn, the γ-ray beam remaining the same. A qualitative explanation is given, and a rough quantitative estimate is made of the effect to be expected, taking into account the various processes involved, such as photoelectric absorption and Compton scattering of the γ-rays in the metal lining, or in the gas, the laws of the passage of β-rays through matter and the relation between the energy lost by β-rays in a gas and the ionisation produced. The variation with frequency of the ionisation per quantum of γ-rays is called the ionisation function, and varies when the ionisation chamber is altered in any way. H. N. A.

HEAT.

537. Effect on Heat Flow through an Insulating Wall of Modifications of the Shape of its Isothermal Boundaries. F. H. Schofield.

Phil. Mag. 6. *pp.* 567–592, *Sept.*, 1928.

The modifications of shape dealt with are (1) a series of thin projections of equal depth and spacing from one of the isothermals, such as would correspond roughly to the metallic ribs of a ship, projecting into a wall of insulation applied internally against its side; (2) and (3) single projections of finite width, respectively internal and external, as in a wall of insulation applied against a surface with a projecting buttress or a recess; (4) a single-rib projection of T section. The solutions, of course, are equally applicable to any other phenomenon which is subject to the Laplace equation, *e.g.*, the flow of electric current in long strips of metal of uniform thickness cut to the shapes indicated. The method of solution is that of conformal representation, using the transformation found by Christoffel and Schwarz [see J. J. Thomson's *Recent Researches in Electricity and Magnetism*, chap. iii]. Tables and graphs are given illustrating the calculations and results. It is pointed out that since the complete system of the isothermals in any case is interchangeable with that of the flow lines, the solution of any problem gives that of the cognate problem obtained by effecting this interchange. T. B.

538. Two New Analogous Equations for the Temperature Field of Turbulent Flowing Liquids and their Meaning for Heat Transmission. L. Schiller.

Phys. Zeits. 29. *pp.* 690–691, *Oct.* 1, 1928.

The paper is a brief theoretical note on the subject of the title. Two equations are derived: (1) $c.d.\bar{u}.l/k =$ constant, where $c =$ specific heat at constant pressure, $d =$ density, $\bar{u} =$ mean velocity, $k =$ conductivity for heat and $l =$ length. It is easily derived that the heat transference number $= \alpha \,.\, l/k$ must be a pure function of $(c.d.\bar{u}.l/k)$. (2) The second equation is derived from the hydrodynamic and thermodynamic differential equations by an assumption that similarity or analogy can be drawn and the temperature field of a moving liquid is similar to a velocity field. Finally, the expression is derived as: $\dfrac{\alpha \,.\, \mathrm{D}}{k} = \dfrac{\psi(\mathrm{P}e)}{4} \,.\, \mathrm{P}e$, where $\alpha =$ the heat transference number, $\mathrm{D} =$ the tube diameter, and $\psi(\mathrm{P}e) =$ the resistance coefficient from the equation for hydraulic resistance, as given by Rey. The analogy (2) gives considerable scope for developing the investigation of the general question of heat transference, examples of which are given. S. G. B.

539. Effect of Magnetic Fields upon Thermal Conductivity of Iron, Copper, Gold, Silver and Zinc. H. M. Brown.

Phys. Rev. 32. *pp.* 508–514, *Sept.*, 1928.

A "bar method" was used to measure thermal conductivity and electrical resistivity for iron, copper, gold, silver and zinc in and out of a longitudinal field of 10,000 gauss, and transverse fields of 8000 and 4000 gauss. Copper-constantan thermocouples "spot" welded to the bars were used to measure the temperatures. For iron, the 10,000 gauss longitudinal field caused a 1·14 % decrease in heat conductivity and the transverse field of 4000 gauss caused a 0·4 % decrease. Electrical resistivity was increased 0·2 % by the 10,000 gauss field. For copper, the thermal conductivity was decreased 0·23 % by the 10,000 gauss field. In all the other cases the fields were shown to produce no effects large enough to detect, although the method would readily show any change as great as 0·04 %. Zinc was used in the ordinary cast form, and in the slowly grown crystal bars. The values of the electrical and thermal conductivities were higher in the crystal bar, but the magnetic fields produced no change in either bar. Thus, contrary to the theories of Livens and others, these metals failed to show an increase in thermal conductivity in strong fields. AUTHOR.

540. Thermal Conductivities of Carbon Monoxide and Nitrous Oxide. H. Gregory and C. T. Archer. *Roy. Soc., Proc.* 121. *pp.* 285–293, *Nov.* 1, 1928.

Pure carbon monoxide for this purpose was prepared by the action of pure re-distilled concentrated sulphuric acid on pure dry sodium formate and pure nitrous oxide by the action of pure sodium nitrite and pure hydroxylamine hydrochloride. The thermal conductivities found at 20° were: CO, 0·0000599; N_2O, 0·00004086. The conductivity data at 0° with temperature coefficients were: CO, 0·00005633 and 0·00317; N_2O, 0·00003740 and 0·00462 respectively. H. H. Ho.

541. Thermal Expansion of Iron Alloys. A. Schulze. *Zeits. f. tech. Phys.* 9. 9. *pp.* 338–343, 1928. *From the Reichsanstalt.*

The iron-silicon system (up to $Si = 8{\cdot}4\ \%$), the iron-aluminium system (up to $Al = 10{\cdot}5\ \%$) and the iron-manganese system (up to $Mn = 14{\cdot}4\ \%$) have been investigated up to 500° C. by means of thermal expansion. The results from the first two systems are characteristic of alloys consisting only of mixed crystals. In the iron-manganese system there is no anomaly until the manganese content reaches about 10 %, but above this value there is a hysteresis range in the expansion at about 200° C. This is presumed to be due to an allotropic change caused by the manganese. A. A. D.

542. New Low-Temperature Laboratory of the Physikalisch-Technische Reichsanstalt in Berlin. W. Meissner. *Phys. Zeits.* 29. *pp.* 610–623, *Sept.* 1, 1928.

The paper gives an account of the buildings, equipment and facilities offered by the new laboratories for low-temperature work. It is divided into seven sections, preceded by a few remarks on the development of the laboratories. Work with liquid hydrogen has been carried on at the Reichsanstalt since 1913 [see Abstract 1809 (1913)]. In 1923 the original plant was replaced by one of ten times the capacity. This enabled a helium-liquefaction plant to be erected in 1925, in which measurements down to 1·2° abs. could be carried out. This had previously been possible only at Leiden and Toronto. The buildings were, however, inadequate, and in 1927 new buildings were erected with special precautions to guard against explosions and fires from escape of hydrogen. The new buildings allow 20 litres of liquid nitrogen and 10 litres of liquid hydrogen per hour to be produced, while the production of liquid helium was not increased beyond that obtainable in 1925. A photograph of the building is given together with plans and diagrams showing the construction of the plant, Linde's method being used for the liquefaction of air. The helium is obtained from two sources, one being from a neon-helium mixture supplied by the Linde-Gesellschaft, and the other from impure helium from the Auer-Gesellschaft and obtained by them from monazite sand. T. B.

543. New Type of Thermostat. V. Čupr. *Zeits. f. Elektrochem.* 34. *pp.* 679–682, *Oct.*, 1928.

This electrical thermostat, which does not admit of a brief description, serves for a wider temperature-range than usual, especially for temperatures from − 40° to + 20°, and readily admits of temperature control to within ± 0·02°. Danger of overheating is avoided by eliminating direct resistance heating, and there is no strong sparking or relay. T. H. P.

544. Fused Salts. W. Herz. *Zeits. f. Elektrochem.* 34. *pp.* 682–684, *Oct.*, 1928.

The further study of the regularities discussed in an earlier paper [see Abstract 518 (1923)] shows that the ratio of the surface tension at the melting point to that at the boiling point of a fused salt is nearly constant for all the alkali halides. The calculations are based upon extrapolations of the surface-tension values of Jaeger, upon the boiling points of Wartenberg and Bosse [see Abstract 519 (1923)], and upon the formula $a^2 = 2\gamma/d$, where a^2 is the capillary constant in mm.², γ the surface tension and d the density of the fused salt. For the salts mentioned, the ratio a_e^2/a_s^2 (e referring to the melting point, s to the boiling point) has the average value 1·37; CsCl, with ratio 2·05, is exceptional. For normal fluids the relation between the a^2 and the molecular weight M at absolute temperature T is, according to Walden, $Ma_e^2/T_e = 3\cdot65$ approx. (I), and to Kistiakowski, $Ma_s^2/T_s = 1\cdot156$ (II). The (I) calculations suggest that the lighter ions (lithium) associate more strongly than the heavy ions. The (II) show no simple relations; this and the marked irregularities of the results are partly ascribed to the uncertainty of the extrapolations. The ratio I/II has approximately the constant value 2 for all the salts, which would indicate that the degree of association varies uniformly between the melting and boiling points. H. B.

545. Vapour Pressures of Binary Systems: Aqueous Solutions of Orthophosphoric Acid, Sodium Hydroxide and Potassium Hydroxide. U. Nakaya. *Faraday Soc., Trans.* 24. *pp.* 543–544, *Oct.*, 1928.

Examination of these systems has been made on the lines of Porter's work [see Abstract 3266 (1928)], equations which are of permissible form and are in agreement with the experimental data over the ranges investigated being obtained. T. H. P.

546. Geometrical Properties of Saturated Vapour Diagrams. G. Bruhat. *Comptes Rendus*, 187. *pp.* 529–531, *Sept.* 24, 1928.

The author discusses the known methods of representing diagrammatically the various states of a fluid, and he considers in particular the liquid state at pressures and temperatures above the critical point whereby the continuation of the melting-point curve may be interpreted beyond the critical temperature. Formulæ are given for the refraction of isochors at the points where crossed by the saturation curve, the existence and the sense of this refraction being deduced immediately from the equilibrium displacement laws. H. H. Ho.

547. Connection between the Deviation from the Straight Line of the Vapour Curves of Binary Mixtures and the Heat of Mixing in the Liquid Phase. J. J. van Laar. *Zeits. f. phys. Chem.* 137. 5–6. *pp.* 421–446, *Oct.*, 1928.

In this paper the author deduces mathematically: (1) the expressions for p, the vapour pressure of a binary mixture; (2) the expression for the heat of mixing w; and (3) the volume change Δv when $x = \frac{1}{2}$, the value of x being given by $c_1 = 1 - x$, $c_2 = x$. The experimental values obtained by G. C. Schmidt for twenty-one binary mixtures [see Abstract 2468 (1926)] are then used to calculate $\Delta a - a_{12} - \sqrt{a_1 a_2}$ and $\Delta b = b_{12} - \frac{1}{2}b_1 - \frac{1}{2}b_2$, and the theoretical significance of the results is discussed. Attention is drawn to the difference in the value of the constants for associated and non-associated liquids and the effect of valence working between different molecules, and also the partial shielding from attractive forces in other cases is considered. T. B.

548. Entropy of Vaporisation of Unassociated Liquids. J. Chipman. *J. Phys. Chem.* 32. *pp.* 1528–1531, *Oct.*, 1928.

In this paper equations expressing the entropy of vaporisation of a normal liquid as a function of its boiling point are compared graphically with recent experimental data. The equation of Kistiakowsky is found valid over a wide range of temperature. This equation is in accord with Hildebrand's rule. Recent data lead to values for the entropy of vaporisation to a concentration of 0·00507 mol. per litre, somewhat higher than that predicted by the Kistiakowsky equation. An expression is derived whereby the entropy of a monatomic liquid may be approximately estimated in the neighbourhood of its boiling point. H. H. Ho.

549. Photographic Study of Detonation in Solid Explosives. Part I. The Development of a Photographic Method for Measuring Rates of Detonation. E. Jones. *Roy. Soc., Proc.* 120. *pp.* 603–620, *Oct.* 1, 1928.

A photographic method for studying detonation in solid explosives has been developed and applied to the measurement of rates of detonation. The rate of movement of the detonation zone along the surface of an explosive cartridge and differences existing between the "surface" and "axial" rates of detonation are considered. It has been shown that, under certain conditions, the disturbance set up in the surrounding medium may cause distortion of the photographic records of the detonation phenomenon, and a method of overcoming this is described. It is confirmed that under certain circumstances the disturbance set up outside an explosive cartridge placed in a gaseous medium travels faster than the detonation phenomenon in the cartridge. The contour of the disturbed region surrounding a particular cartridge of explosive has been approximately determined at definite intervals from the instant at which the disturbance is first initiated. Photographic determinations of velocities of detonation are found to agree with those obtained by the Dautriche method. Some results are tabulated to illustrate the two stable velocities of detonation peculiar to the gelatinous explosives and the effect of the nitroglycerine content of a powder explosive on its velocity of detonation. A method is given for determining the approximate duration of the detonation phenomenon over a transverse section of a cartridge. The stable form assumed by the detonation front inside a 7·6 cm. diameter cartridge of a certain explosive has been determined. J. N. P.

550. Sama Condition. E. A. Holm. *Comptes Rendus*, 187. *pp.* 531–534, *Sept.* 24, 1928.

Dallwitz-Wegner has submitted the hypothesis that gravity produces a thermal gradient within a body whether solid, liquid or gas, the effect being designated as the "Sama condition." If this state really exists, then, within a sufficiently rarefied gas at a uniform temperature, there should occur a *gravimolecular pressure*, which the author has now definitely established by means of a special experimental arrangement discussed in the present paper. This gravimolecular pressure is found to increase with the ordinary gas pressure and directly proportional to it at extreme rarefactions. [See also Abstract 1944 (1928).] H. H. Ho.

551. Quantisation of the Ideal Monatomic Gas. G. Polvani. *N. Cimento*, 5. *pp.* 256–264, *July*, 1928.

Results are obtained from applying the general equations of thermodynamics to the new equation of state proposed by Fermi, on a quantic basis, for the ideal monatomic gas. In reversible adiabatic transformations the degree of degeneration remains constant, and the internal energy is proportional to the absolute temperature, but only for adiabatic transformations. The gas itself is, contrary to Joule's law, subject to an internal pressure, always negative. Only some of the molecules are, instant by instant, in motion; the higher the temperature the larger is this portion. In Joule's adiabatic transformation there ought to be an increase of temperature. The difference between the two specific heats tends to zero with the temperature T, being proportional to the cube of T. A. D.

552. Hydrodynamics and the Kinetic Theory of Gases. Y. Rocard. *Ann. de Physique*, 10. *pp.* 345–348, *Sept.–Oct.*, 1928.

The present paper points out some small errors, the correction of which leads to different expressions from those given in the former paper [see Abstract 2727 (1927)] for the coefficients of viscosity and of thermal conductivity of compressed gases. T. B.

553. Equation of State of a Perfect Gas. R. D. Kleeman. *Phil. Mag.* 6. *pp.* 743–744, *Oct.*, 1928.

In a recent paper [see Abstract 2778 (1928)] the author showed from thermodynamical considerations of the zero of entropy that the equation of a perfect gas, or the limiting equation of state of the substance when the volume is infinitely large, is strictly $pv = \mathrm{MRT}\xi$, where ξ is a function of the volume v, absolute temperature T, and mass M in mols. The proof is now given in an improved form, and the result is also shown to be obtainable independent of considerations of the zero of entropy. H. H. Ho.

554. Equation of State of a Mixture determined from the Equations of State of its Constituents, and its Application in determining the Physical and Chemical Properties of a Mixture

in Terms of Those of its Constituents. R. D. Kleeman. *Frank. Inst., J.* 206. *pp.* 511–523, *Oct.*, 1928.

The equation of state of a mixture of M_a gramme-atoms of a, M_b gramme-atoms of b, etc., which may combine to form various molecules, is shown to be $p = \psi[(A_1M_a + B_1M_b)/v, (A_2M_a + B_2M_b)/v \ldots]$, where $A_1, A_2 \ldots B_1, B_2 \ldots$ are functions of the temperature T. The equations of state of the constituents are shown to be $p_a = \psi(A_1M_a/v, A_2M_a/v, \ldots)$; $p_b = \psi(B_1M_b/v, B_2M_b/v, \ldots)$, etc., which have the same functional form, which is, therefore, independent of the nature of the mixture or pure substances we are dealing with. Hence, if the equations of state of a number of pure substances be known, the equation of state of any given mixture of these constituents may be written down. The number of forms of ψ is discussed, and is thought to correspond to the roots of p when the equation of state is written in a form not involving the extraction of roots. If the exact form of the function ψ were known, it should be possible to express every property of a complex substance in terms of the same properties of the constituents. Thus, the various magnetic, electrical and other properties of, say, HCl should be possible of being expressed in terms of those of H_2 and Cl_2. T. B.

555. Entropy and Thermodynamic Potentials of Real Gases and Mixtures of Real Gases and a Mass Action Law for Chemical Reaction between Real Gases. Part II. Integrated Equations. Part III. Relations for Pure Gases and Equilibrium Pressure of a Gas in a Mixture. J. A. Beattie. *Phys. Rev.* 32. *pp.* 691–705, *Oct.*, 1928.

Part II.—A new equation of state is used for the integration of the general thermodynamic equations of the first paper [see Part I, Abstract 2151 (1928)]. Energy, heat content, entropy and thermodynamic potentials of a mixture of real gases, as also the chemical potential and fugacity of a gas in a mixture, are expressed as integrated functions of V., T., ν_1, $\nu_2 \ldots$, and the constants of the equation of state of the pure gases composing the mixture. The thermodynamic potential is shown to be given by an expression which is fundamental in the Gibbs' sense. The "mass action constant" is expressed in terms of the variables V. T. $x_1, x_2, \ldots \nu_1, \nu_2 \ldots$ and the equation of state constants of the pure gases composing the equilibrium mixture. A mass action law for reactions between real gases is deduced. The integration constants are evaluated for non-isothermal and isothermal variations when the system consists of chemically reactive gases, and also for similar variations for non-reacting gases.

Part III.—The method used in Parts I and II is used to derive the general equations and relations for the thermodynamic potentials of pure real gases, and for the equilibrium pressure of a gas in a mixture. Integrated expressions are obtained for all of the thermodynamic functions by means of an equation of state. The method is extended to a discussion of the conditions of state of two mixtures of gases separated by a semi-permeable membrane, which is permeable to one or more of the gases. It is shown that the chemical potential of each such gas is the same on both sides of the membrane. S. G. B.

556. Absolute Zero of Internal Energy and Entropy, and the Corresponding Inertness of Matter. R. D. Kleeman. *Science,* 88. *pp.* 235–236, *Sept.* 7, 1928.

The author refers to his former papers on this subject and notes here that when the absolute temperature $T = 0$, matter possesses a remarkable inertness to temperature changes. This suggests that at $T = 0$ the nature of an atom differs considerably from that which it has at higher temperatures, this difference being, no doubt, associated with a change in electronic configuration. J. J. S.

557. Internal Energy and Entropy of a Substance or Mixture. R. D. Kleeman. *J. Phys. Chem.* 32. *pp.* 1396–1410, *Sept.*, 1928.

The author has previously shown that the controllable internal energy and the controllable entropy are each zero for a substance or mixture in the condensed state under its vapour pressure at the absolute zero of temperature, moreover, that the entropy is also zero for all other states at the absolute zero of temperature. In the present paper formulæ for the internal energy and entropy are developed. The additive laws deduced may be used to calculate the entropy, free energy of formation and the constant of mass action of compounds that have not yet been discovered in the laboratory. J. J. S.

558. Estimation of the Absolute Zero. Inversion Point of the Second Order. W. Jazyna (Jacyno). *Zeits. f. Phys.* 51. 3–4. *pp.* 292–307, 1928.

The paper is threefold: (1) Different methods for the calculation of the absolute temperature are reviewed. (2) The absolute "thermodynamic" temperature and the absolute temperature of an "ideal" gas scale are compared. The limits of absolute zero are examined from atmospheric pressure (1 atmosphere) to the inversion point of the second order. (3) The limits of error are defined. The absolute error of the approximate value of $T_0 = 273°$ C. from thermodynamic principles combined with the researches of Joule and Thomson is interpolated to be $\Delta t < 0{\cdot}1°$ C. Ignoring the interpolation and taking into consideration the conditions and characteristics at the inversion point of the second order the error lies between $\Delta t < 0{\cdot}8°$ C. and $\Delta t < 0{\cdot}4°$ C. S. G. B.

559. Determination of the Stefan-Boltzmann Radiation Constant using a Callendar Radio Balance. F. E. Hoare. *Phil. Mag.* 6. *pp.* 828–839, *Nov.*, 1928. *Supplement.*

The determination of σ in the well-known formula $E = \sigma(T_1^4 - T_2^4)$ has been attempted by a number of observers, but the agreement is not good. The source of radiation employed by the present author is a wire-wound electric furnace, the temperature of which is measured with a platinum resistance thermometer, and the receiver is the radio balance designed by Callendar [see Abstract 620 (1911)]. In this instrument the radiation is received in a copper cup 3 mm. diameter and 8 mm. deep, and is balanced and determined by the heat absorbed by the Peltier effect in a thermocouple through which a measured current is passed. Care is taken that both source and receiver are full radiators or "black bodies." Conditions are varied widely, furnace temperatures from 716° to 985° C., distance of furnace 21 to 41 cm., total microwatts 200 to 1157. The mean value obtained for σ is $5{\cdot}735 \times 10^{-5}$ c.g.s. units. From a critical examination of the results obtained by a variety of methods the value of the constant is thought to lie between $5{\cdot}70$ and $5{\cdot}75 \times 10^{-5}$ c.g.s. units. T. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

560. "Action" of an Electromagnetic Field. S. R. Milner. *Roy. Soc., Proc.* 120. *pp.* 483–502, *Oct.* 1, 1928.

Larmor's development of Maxwell's equations by an application of the principle of least action with the action put equal to $\iint \frac{1}{2}(h^2 - e^2)d\mathrm{V}dt$ is defective, (*a*) because it rests on an absolute identification of magnetic with kinetic energy, (*b*) because it starts from a form of the principle which is not valid in the special relativity theory. These objections are overcome in the present treatment, which employs the notion of the *field* as a moving medium possessing mass, velocity, kinetic and potential energy, etc. The electromagnetic Hamiltonian action thus determined is

$$\mathrm{A} = \mp \iint \tfrac{1}{2}\{(e^2 - h^2)^2 + 4(eh)^2\}^{\frac{1}{2}} d\mathrm{V}dt,$$

the integral extending over a given region of space-time. This quantity is proved to possess a stationary value in the electromagnetic field subject to the conditions equivalent to those characterising Hamilton's principle in dynamics. W. S. S.

561. Magnetic Moment of the Electron. C. G. Darwin. *Roy. Soc., Proc.* 120. *pp.* 621–631, *Oct.* 1, 1928.

The solution of the Dirac wave equations gives a distribution of charge density and current density, to which the electromagnetic equations are applied and the resultant field shown to correspond partly to convection of electricity, partly to an intrinsic magnetisation, and for high-speed electrons, in addition to an electric moment. A comparison made between electron and light waves is expressed loosely by the remark: "A light quantum is an electron without charge or mass." W. S. S.

562. Diffraction of the Magnetic Electron. C. G. Darwin. *Roy. Soc., Proc.* 120. *pp.* 631–642, *Oct.* 1, 1928.

The question is examined theoretically, using Dirac's wave equations, whether electrons diffracted by a slit or grating, or reflected from a mirror, should show "polarisation," *i.e.*, a preferential direction of magnetisation. The general answer is negative. The case of diffraction by a line grating is solved. If the grating is supposed to exert only periodic electric or only periodic magnetic forces, the sole effect on an initially "polarised" beam is a rotation of the direction of magnetisation. The simultaneous action of electric and magnetic forces may produce partial polarisation, but the case is remote from possible experimental conditions. W. S. S.

563. Method of Solution of Potential Problems. M. J. O. Strutt. *Ann. d. Physik,* 87. 2. *pp.* 153–175, *Oct.* 5, 1928.

In place of the usual integral equation of the second kind for the solution of the Dirichlet problem the use of an integral equation of the first kind is proposed. The latter equation gives at once the true charge, whilst by means of an integral equation of the second kind the thickness of an imaginary double layer is first of all obtained, and then from this, after differentiation and integration, the true charge. The method is applied to some two-dimensional problems: (1) *m* circular cylinders in the angles of a regular polygon (limiting cases: two parallel circular cylinders and infinitely many parallel circular cylinders in one plane); (2) arrangement as (1) with a circular cylinder in the centre of the polygon; (3) arrangement as (1) with a circular cylinder enveloping the polygon; (4) infinitely many circular cylinders in two parallel planes. Problems (1), (2) and (4) have importance both for electrostatic and for high-frequency electromagnetic cases. Problem (4) applies to high-frequency current distribution in a coil; problem (3) to heat conduction and potential cases of the cable theory; a combination of (2) and (3), to the electric field of a kathode glow tube. J. J. S.

564. Contact Theory of Frictional Electricity. E. Perucca. *Zeits. f. Phys.* 51. 3–4. *pp.* 268–278, 1928.

An investigation was carried out which maintained the view of the existence of the Volta effect of the first kind, *i.e.*, the existence of an electrostatic field in the dielectric around two insulators brought into contact. The favourable outcome of the research applies to the contact between a solid and a liquid insulator; but there is no ground for supposing that there should be any substantial difference in behaviour in the case of two solids in contact. The result obtained affords an argument in favour of the contact theory of frictional electricity. J. J. S.

565. Contact Electric Layers. M. Satô. *Tohoku Univ., Sci. Reports*, 17. *pp.* 1051–1063, *Sept.*, 1928. *In English.*

When a melted insulator was solidified on a metallic plate and then separated from it an electric charge appeared on the contact surface of the dielectric. Its surface density was sometimes very large and sometimes very small, and occasionally its sign was reversed. This anomaly was explained by the presence of double electric layers. When the specimen without this upper layer was enclosed in tinfoil, the electric layer of opposed sign gradually appeared on the surface of the specimen and attained a permanent equilibrium state. The reversal of the " electret-pole " and its permanency were thus explained by the formation of the double layers. [See Abstract 347 (1926).] J. J. S.

566. Origin of Cosmic Rays. R. A. Millikan and G. H. Cameron. *Phys. Rev.* 32. *pp.* 533–557, *Oct.*, 1928.

The consequences of the hypothesis that the cosmic rays arise in the sudden union of positive nuclei and electrons to form heavier atoms are worked out compared with observation. The frequency of the radiation emitted in such a union is computed, using Einstein's formula $Mc^2 = E$, from the difference in mass of the constituents before and after union; the exact determinations of atomic weights by Aston are employed for this purpose. Application of Dirac's formula then gives the penetrating power of the radiation. The observed cosmic rays of absorption coefficients 0·08 and 0·04 are identified as due to the formation *in a single act* of oxygen and silicon respectively. The cosmic ray of absorption coefficient 0·30 (this ray comprises about 80 % of the observed radiation) corresponds to the sudden union of four positives and two electrons to form helium. There is no indication of a cosmic ray due to the transformation of the whole mass of the hydrogen atom into radiation. Evidence is given to show that cosmic rays do not originate in the stars, but only in the depths of space where temperature and densities are practically zero. W. S. S.

567. Discovery and Investigation of Cosmic Rays (Ultra γ-Rays). K. Bergwitz, V. F. Hess, W. Kolhörster and E. Schweidler. *Phys. Zeits.* 29. *pp.* 705–707, *Oct.* 1, 1928.

The authors criticise many of the opinions and conclusions expressed by Millikan and Cameron [see Abstract 1343 (1928)] regarding the discovery of cosmic rays, their absorption coefficient and theoretical considerations regarding their origin. The earlier experiments and conclusions of Hess, Kolhörster, Nernst and Bergwitz have been overlooked.

R. S. R.

568. Piezoelectricity in Crystals. W. Schneider. *Zeits. f. Phys.* 51. 3–4. *pp.* 263–267, 1928.

When investigating crystal structure, it is often important that the class of the crystal should be determined and that it should be decided whether the crystal is centro-symmetrical or not. For this purpose piezoelectrical observations may be employed, for the detection of piezoelectricity indicates that the crystal has not a centre of symmetry. The author describes an arrangement of apparatus for testing the piezoelectrical behaviour of crystals and gives lists of various crystals with the class to which they belong, as determined by electrical tests. J. J. S.

DISCHARGE AND OSCILLATIONS.

569. Electric Arc in Gases at Low Pressures. F. H. Newman. *Phil. Mag.* 6. *pp.* 811–817, *Nov.*, 1928. *Supplement.*

Describes experiments on the starting conditions of a type of arc, previously described by the author, which can be maintained at very low pressures. A third electrode is necessary in the containing vessel in order that a starting ionising discharge can be passed. This momentary discharge must be fairly strong, and the most consistent results are obtained when it is unidirectional with a very high potential difference. The main discharge cannot be obtained at pressures above 10 mm. of mercury and with the applied voltage below 108 volts. Using iron electrodes, the radiation emitted initially is entirely that from the surrounding gas molecules, but when the electrodes heat up, the characteristic iron radiation is obtained. The function of this initial discharge is to provide those electrons usually supplied by a hot body in other forms of arc discharge. Certain fused salts have the property of facilitating the starting of the arc. This property is due to the intense local heating brought about by the bombardment with positive ions from the initial discharge and the consequent emission of a copious supply of electrons. Further, the initial discharge modifies the surrounding gas, these modifications being more easily ionised than the gas in its normal state.

R. C. F.

570. Investigation of Predischarges. F. Trey. *Phil. Mag.* 6. *pp.* 854–857, *Nov.*, 1928. *Supplement.*

Using the "Schlieren" method of Toepler and Mach results were obtained which show that with long sparks, where the electrode distance is much larger than the radius of curvature of the electrodes, the spark track is produced by the positive predischarge. The author considers the method used superior in certain respects to the shadow method of Foley recently employed by Zinszer [see Abstract 2460 (1928)]. [See also Abstract 2129 (1922).] A. W.

571. Ultra-Violet Radiations emitted by Point Discharges. J. Thomson. *Phil. Mag.* 6. *pp.* 526–546, *Sept.*, 1928.

Preliminary experiments are described on the variation with pressure of the ionising and photoelectric radiations from hydrogen and nitrogen when the gases are excited by a discharge, and on the variation of the intensity of these radiations when the pressure is kept constant and the discharge current is varied. The curves obtained depend upon both absorption and emission variations, and an attempt is made to estimate the relative importance of the two effects. Tentative explanations of the various phenomena are put forward. Further work will be necessary to decide between them. In the case of oxygen, a spontaneous ionisation phenomenon was observed which may be due to the gradual change of the O_3 molecule, formed during the spark discharge, to the normal O_2 molecule. A. W.

572. Oscillating Discharge in Hydrogen. Z. Bay and W. Steiner. *Zeits. f. Elektrochem.* 34. *pp.* 657–662, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

It was shown by a series of exact experiments that the continuous spectrum in hydrogen persisted even after very thorough drying of the hydrogen and drying of the quartz tube by oscillatory discharge. The continuous spectrum is, therefore, characteristic of the hydrogen and not of the impurities present. The construction of a discharge tube for high current loading is described, which gives an intense hydrogen spectrum. This tube is a convenient source of light for absorption experiments of light having wave-lengths between 3300 and 1900 Å. F. J. B.

573. Discharge Figures on Photographic Plates. T. Terada. *Kyoto Coll. Sci., Mem.* 11. *pp.* 355–359, *Sept.*, 1928. *In English.*

A description is given, with photographs, of the effects obtained on superposed photographic plates subjected to an electric discharge, and the effects on the different plates are correlated. A. W.

574. Surge Potentials and Spark Images. W. Rogowski and R. Tamm. *Arch. f. Elektrot.* 20. *pp.* 625–634, *Sept.* 17, 1928.

Difficulties have been shown to exist in explaining electric breakdown phenomena in gases by means of Townsend's theory [see Abstracts 188 and 3191 (1927)]. The present paper describes work bearing on electric breakdown, and the results obtained appear to be incompatible with Townsend's theory. Surge potentials were applied to a spark gap in an exhausted glass vessel and photographs were taken of the light phenomena which occurred when the surge potentials were applied. The space between the electrodes was subjected to the ionising effect of a few milligrammes of a radium preparation to facilitate the passage of the sparks between the electrodes [see Abstracts 2458 and 2481 (1928)]. Oscillograph records of the surges were also obtained and an ordinary camera was used simultaneously with a spectrograph. Numerous photographs are given, and the discussion of the results obtained shows that in the first phase of the discharge, lasting for a time of the order of 10^{-6} second, the observed phenomena are in direct opposition to what would be anticipated from Townsend's theory. A. W.

575. Effect of Temperature on the Auto-Electronic Discharge. N. A. de Bruyne. *Cambridge Phil. Soc., Proc.* 24. *pp.* 518–520, *Oct.*, 1928.

Pforte and the author have recently shown that it is possible to separate the thermionic and auto-emissions from a hot kathode, since the thermionic emission is found to increase in accordance with a relation derived by Schottky. In this way it has been shown that within the limits of experimental error the auto-emission is independent of the temperature up to 1944°, which was the highest temperature investigated. A. W.

576. Comparison of Measurements of Critical Potentials of Mercury Vapour. J. C. Morris, Jr. *Phys. Rev.* 32. *pp.* 447–455, *Sept.*, 1928.

The critical potentials of Hg vapour were examined with a tube constructed to permit the use of a number of different methods. For detecting critical potentials other than those of ionisation, the Hertz method proved much the most satisfactory. Of the thirteen critical potentials found below ionisation, ten have definite spectroscopic interpretation and the remaining three, which are probably due to mercury molecules, confirm similar values reported by Miss Messenger. The partial current method of Franck and Hertz showed less resolving power, but otherwise gave good agreement with the Hertz method. The Franck and Einsporn method gave peculiar results, suggesting that it detected only photoelectric effects and not metastable atoms, and that the failure to show the other critical potentials was due to features of tube design which eliminated inelastic impacts in the region around the filament where space charge acts to limit emission. Compton's method for studying ionisation proved very satisfactory, since no effects of other types of inelastic impacts were detected. Three ultra-ionising potentials at 10·65, 11·34, 11·78 were found in good agreement with Lawrence, although the present results do not show the regions of maximum ionisation probability near these values, as reported by him. An attempt to test the molecular origin of these high ionising potentials led to negative results. AUTHOR.

577. Ionising Potentials of Methane, Ethane, Ethylene and Acetylene. J. C. Morris, Jr. *Phys. Rev.* 32. *pp.* 456–458, *Sept.*, 1928.

After preparation and purification by the most approved methods, the gases methane, ethane, ethylene and acetylene were introduced into an ionisation tube of the Mackay type and their ionisation potentials measured. The calibration of the apparatus was made with the aid of Hg vapour and He gas as standards. The values found are: methane 14·4 volts, ethane 12·8 volts, ethylene 12·2 volts, acetylene 12·3 volts, and are believed to be correct within 0·2 volt. AUTHOR

578. Temperature of the Kathode as a Factor in the Sputtering Process. L. R. Ingersoll and L. O. Sordahl. *Phys. Rev.* 32. *pp.* 649–656, *Oct.*, 1928.

Gold, platinum and nickel show an increase in the rate of sputtering in argon with increase in kathode temperature. The lower the sputtering voltage the more pronounced the effect. Films sputtered from a hot kathode show considerable initial ageing, *i.e.*, suffer less change in resistance on baking and show a more definite crystal structure than those from a cold kathode. While evidence is presented to show that the "explosion theory" of sputtering may have a certain basis of fact, especially as regards starting conditions, the results are, on the whole, consistent with the explanation of sputtering as essentially a vaporisation process. The indications are, however, that ordinary evaporated films, even when produced under the same pressure as sputtered films, contain less gas, pointing to the excitation accompanying the discharge as an important factor in the process of gas occlusion in the films. AUTHORS.

579. Electrical Properties of Neon. J. S. Townsend and S. P. MacCallum. *Phil. Mag.* 6. *pp.* 857–878, *Nov.*, 1928. *Supplement.*

Experiments were made with a new type of apparatus to determine the coefficients α and β which occur in the formula for the rate of increase of current with the distance between the electrodes in a uniform electric field [Abstract 186 (1927)]. The results show that α is from about 9 to 13 times β, depending on the pressure. Near the point corresponding to the minimum sparking potential α is nearly 10 times β. The ratio β/α is much greater in neon than in other gases. The minimum sparking potential of 186 volts occurred when the product of the gas pressure p (in mm.) and the distance S (in cm.) between the plane electrodes had the value 3. The results are in agreement with the hypothesis that the process of ionisation represented by the coefficient β is due to positive ions. Small amounts of impurities were found to affect the measurements appreciably, but the passage of a high-frequency discharge through the gas quickly removed the impurities. The sparking potentials have also been determined for helium with the new apparatus. As in neon, the sparking potentials were higher in the pure gas than with small traces of impurities present, and the impurities are removed by the electrodeless discharge. The minimum sparking potential for pure helium was found to be 223 volts near the point where the product $p\text{S} = 4$. A. W.

580. Penetration of an Electric Field through Wire Gauze. W. B. Morton. *Phil. Mag.* 6. *pp.* 795–801, *Nov.*, 1928. *Supplement.*

In a method frequently used for the investigation of the mobilities of gaseous ions, the apparatus consists of a cylindrical vessel which is divided into two compartments by a partition of wire gauze. Ions are generated in one compartment and are acted upon by a steady electric field which pushes them through the meshes of the gauze into the other compartment. Here they come under the influence of an alternating field. If this is strong enough, and the alternations slow enough, ions leaving the gauze will be carried to the plate which forms the other boundary of the field before they are turned back by the reversal of the electric force. The plate is connected to an electrometer, so that the current reaching it can be measured for different values of the alternating p.d. The mobility can be deduced from the value of the smallest field which can produce a current between gauze and plate. The values arrived at by different workers vary rather widely, and it has been suggested that a source of error is to be found in the interpenetration of the two fields through the meshes of the gauze. This paper examines the question as a purely mathematical problem to find an upper limit to the importance of this source of error. The conclusion reached is that it appears probable that the interpenetration of the fields is not a source of serious error in the measurements. J. J. S.

581. Thermionic Emission of Incandescent Platinum in Iodine Vapour. S. Kalandyk. *J. de Physique et le Radium*, 9. *pp.* 231–235, *July*, 1928.

It is shown that iodine vapour only increases the electronic emission from heated platinum, no alteration being produced on the ionic emission. This increase is greatest at low temperatures of the platinum filament and decreases as the temperature increases, until at high temperatures the value is the same as for platinum in a vacuum. The increase in thermionic emission is apparently due to a layer of platinum iodide which is formed on the filament and vaporises as soon as it is formed at the higher temperatures, thus producing no effect. An approximately linear relation connecting emission and pressure of iodine vapour is obtained with low platinum temperatures, but at high temperatures a complicated character is shown by the thermionic emission. R. C. F.

582. Measurement of the Development of Heat by the Condensation of Electrons in Metals. R. Viohl. *Ann. d. Physik*, 87. 2. *pp.* 176–196, *Oct.* 5, 1928.

A method and apparatus are described by which the condensation heat of electrons can be measured. The electrons issuing from an oxide kathode were accelerated and deflected through openings to a metal block. The receiving block was specially arranged on the principle of a Faraday cage in order that errors due to secondary emission might be avoided. The heating was measured by means of a copper-constantan thermo-element. The kinetic energy excited by the accelerating field can be easily and accurately ascertained by means of a spectral distribution of velocity produced by deflection. A neglect of the contact potential leads to false results. For the case of electrons falling into nickel the condensation heat was found to be 97,800 ± 9800 cal. referred to the mol.

J. J. S.

583. Scattering of Positive Ions from a Platinum Surface. R. W. Gurney. *Phys. Rev.* 32. *pp.* 467–477, *Sept.*, 1928.

The scattering of positive ions with comparatively high momenta has been investigated, using a heated platinum target, the scattered ions passing through two slits into the electric and magnetic analysing fields of a positive ray box. The source of the potassium, cæsium or lithium ions used was an oxide catalyst, and could be rotated round the target so as to bombard it from different angles. An accelerating voltage was applied to the ions, and those scattered at a given angle are nearly homogeneous in velocity. The energy retained after scattering rises from 20 % of the initial energy to over 80 % as grazing incidence is approached. With a cold target it falls to 40 % of the initial energy near grazing incidence; this is due to an adsorbed layer of molecules on the platinum. The angular distribution of the scattering was measured with an apparatus in which a collector could be rotated round the target. For a fixed angle of incidence the number of particles scattered normal to the target is very small or even zero, but increases steadily with increasing angle of reflection. The intensity of scattering rises to a sharp maximum at about 40 volts.

The critical energy is the same for Co, K and Li ions. Difficulties in the theoretical explanation of the results are discussed. H. N. A.

584. Effective Cross-Section of Gas Molecules towards Alkali Ions at 1–30 Volts Velocity. C. Ramsauer and O. Beeck. *Ann. d. Physik*, 87. 1. *pp*. 1–30, *Oct*. 5, 1928.

The objective of the present investigation [see Abstract 1358 (1928)] is the experimental determination of the effective cross-section of neutral gas molecules with respect to slow-moving alkali ions by means of the established magnetic method. Full experimental details and necessary precautions to secure accuracy are included. A glowing alkali-amalgam coated strip of platinum or platinum-iridium alloy served as ionic source. The alkalis employed included Li, Na, K, Rb, Cs, and the gases He, Ne, A, H_2, O_2 and N_2. The velocity range lay between 1 and 30 volts. The effective cross-section curves of all combinations beginning at the greater velocities rose at first slowly and then more rapidly, turning steeply upwards between 2 and 1 volts. For a given velocity—*e.g.*, 16 vols.—the effective cross-section curves were higher the larger the atomic number of the alkali, and, for a given alkali ion, the experimental values exceeded those calculated from the kinetic gas molecule radii the greater the atomic number. A comparison is made with the results from related investigations, and relations are derived between the sum of the effective radii found and the data calculated from the radii of the outer electronic shells of the alkalis and the gas kinetic radii of the neutral molecules.

H. H. Ho.

585. Mobility of Ions in Air. Part V. Transformation of Positive Ions at Short Ages. A. M. Tyndall, G. C. Grindley and P. A. Sheppard. *Roy. Soc., Proc.* 121. *pp*. 185–194, *Nov*. 1, 1928.

The effect on the rate of transformation of positive ions [see Abstract 1434 (1926)] of adding certain gases and vapours to the air in which they are formed has been studied by an air-blast method. It is shown that a small quantity of ozone, generated either by an ozoniser or by a point discharge, produces a marked increase, and this may arise *via* the α-rays from polonium in a closed vessel. It is argued that this effect may explain certain discrepancies between the results of mobility measurement by various observers using different methods. The rate of transformation is greatly retarded if, before entering the air blast, the ions are formed in an atmosphere containing the vapour of certain alcohols of the aliphatic series. The significance of the results is discussed, but speculation regarding the nature of the initial positive ion is regarded to be premature at this stage. H. H. Ho.

586. Absorption Coefficient of Slow Electrons in Mercury Vapour. T. J. Jones. *Phys. Rev.* 32. *pp*. 459–466, *Sept*., 1928. *Abstract*.

An account is given of measurements by two different methods of the absorption coefficient α in mercury vapour for electrons with energies of 0·5 up to 400 volts. The experiments described in the first part of the paper were made by Ramsauer's method, in which a homogeneous electron beam is obtained by bending the electrons through a series of slits suitably arranged in a magnetic field. The second part of the paper deals with experiments made by an arrangement which gave a fairly homogeneous beam of electrons without the use of a magnetic field. In each method the fraction of the initial electrons which traversed a given distance through the vapour without suffering collision was measured, and this enabled α to be calculated. The results obtained by the two different methods were found to be in fair quantitative agreement. The absorption coefficient increased continually as the energy of the electrons was reduced down to 0·5 volt. No evidence was obtained of the sharp decrease in α for electrons slower than 3 volts, as reported by Beuthe. The results, when compared with those obtained by former workers, were found to be in fairly good agreement with those of Maxwell over the whole range of electron energies and with those of Brode at the lower energies. AUTHOR.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

587. Electrical Conductivity of Tellurium and of Liquid Mixtures of Tellurium and Sulphur. C. A. Kraus and E. W. Johnson. *J. Phys. Chem.* 32. *pp.* 1281–1293, *Sept.*, 1928.

The specific resistance of liquid tellurium at its melting point is approximately $\frac{1}{15}$ that of solid tellurium at the same temperature. In both cases the specific resistance is an exponential function of the temperature. Addition of sulphur causes a very marked increase in the value of the specific resistance. At concentrations above 30% of sulphur polarisation effects became noticeable, indicating the presence of ordinary ions. The specific resistance of the mixtures approximately decreases exponentially with temperature. F. J. W.

588. Electrical Conductivity of Potassium Chloride Vapour. T. Peczalski and J. Cichocki. *Comptes Rendus*, 187. *pp.* 534–536, *Sept.* 24, 1928.

Experimental details with diagram are given together with the necessary precautions observed for securing that the actual conductivity measured was that due to the electrolysis of KCl vapour. From the data obtained, it appeared that the number of molecules of KCl vapour dissociated at the temperature (550°) of the experiments was 0·002 of the total number. When previously used copper electrodes were employed in the absence of KCl vapour, a luminous discharge was observed, due doubtless to electronic emission from the electrodes. The amount of KCl thus absorbed by copper is not detectable by ordinary analytical methods. H. H. Ho.

589. Electrical Resistance of Alloys under Pressure. C. W. Ufford. *Phys. Rev.* 32. *pp.* 505–507, *Sept.*, 1928.

The average pressure coefficients, up to 12,000 kg./cm.^{2}, are given in tabular form of the electrical resistance of three series of alloys: lithium-tin, bismuth-tin and calcium-lead, and for one calcium-magnesium alloy of 10 A% magnesium. The variation with concentration of the pressure coefficient, the temperature coefficient and the relative change of the temperature coefficient with pressure for these three series is comparable with the variation of the structure of the alloys as given by the equilibrium diagram. The conductivity and the pressure coefficient of a dilute solid solution of bismuth in tin are the same as those of pure tin under pressure. As hydrostatic pressure and impurities have the same effect on the pressure coefficient, electric conduction probably depends on the geometrical properties of the conductor. AUTHOR.

590. Electrical Conductivity of Arsenic and Antimony at Low Temperatures. J. C. McLennan, C. D. Niven and J. O. Wilhelm. *Phil. Mag.* 6. *pp.* 666–672, *Oct.*, 1928.

Crystals of arsenic and antimony were prepared and their resistance measured at various temperatures between room-temperature and the temperature of liquid helium. The resistance of a chip of antimony was also measured. The conclusions reached were as follows: (1) The resistance temperature curve of the antimony crystal is not very different from that of the piece off the mass of metal. (2) The curves arrange themselves as would be expected from the arrangement of the metals in the periodic table. (3) The temperature resistance curve for arsenic resembles that of many other pure metals, but there is a very decided departure from the law stating that the electrical resistance is proportional to the absolute temperature. (4) The results show that in the case of both As and Sb resistance at low temperatures approximates to a definite residual value. This property is common to most pure metals. The arsenic crystal was measured to 2·42° K., and the antimony crystal to 2·43° K.; neither was found to be superconducting. J. J. S.

591. Resistance of Cæsium, Cobalt and Chromium at Low Temperatures. J. C. McLennan, C. D. Niven and J. O. Wilhelm. *Phil. Mag.* 6. *pp.* 672–677, *Oct.*, 1928.

The resistance of cæsium in a fine capillary tube was measured at room-temperature and at the temperatures of liquid air, liquid hydrogen and liquid helium. The behaviour of cæsium differs from that of most pure metals: its resistance does not approach a limiting value at low temperatures, but continues to decrease with temperature below 4° K. The resistances of sodium, potassium and rubidium approach a certain limiting value at low temperatures. The resistance of chromium was measured at 2·25° K., and that of cobalt at 2·5° K.; neither was found to be superconducting. Both these metals had very small temperature gradients below the temperature of liquid hydrogen; the resistances of both at low temperatures was almost independent of temperature. There is some indication that on passing from chromium to copper the resistance falls from a high value for chromium to a low one for iron, and then rises again for cobalt and nickel and falls eventually to a very low value for copper. The relation of these results to atomic structure is discussed. The importance of the influence of the structure of the core of the atom on the electrical conductivity of a pure metal is pointed out. J. J. S.

592. Effect of Cadmium as an Impurity in Lead on the Conductivity of Lead. J. C. McLennan, C. D. Niven and J. O. Wilhelm. *Phil. Mag.* 6. *pp.* 678–685, *Oct.*, 1928.

A pure specimen of lead was alloyed with various quantities of cadmium with a view to testing the effect on superconductivity. The experiments described are preliminary to a fuller investigation of superconductivity and show that a metallic impurity in a superconductor will not necessarily eliminate the property of superconductivity. Various alloys of Cd and Pb were found to be superconducting at a temperature very near to that at which the pure lead was superconducting. An alloy with 5·19 % of Cd became superconducting at four-tenths of a degree below the superconducting temperature of lead, and a 1·88 % alloy at two-tenths below. The amount of cadmium seemed to affect the temperature at which the

resistance of an alloy entirely vanished, but not to affect the temperature at which the phenomenon of superconductivity started to make its appearance. Certain changes of resistance which were observed seemed to be due to a sort of ageing effect and this is to be further investigated.
J. J. S.

593. Determination of a Limit of the Number of Free Electrons in a Metal. F. E. Colpitts. *Frank. Inst., J.* 206. *pp.* 489–501, *Oct.*, 1928.

According to Sommerfeld's statement of the electronic theory of metallic conduction [see Abstract 1368 (1928)] the electrons diffuse by electronic pressure over a finite depth from the surface depending upon the electronic concentration. The author calculated the potential difference between two points of a metallic conductor, as a function of *n*, the number of free electrons per unit volume of the metal, with different concentrations of electrons. Measurements were made on sputtered films of Au and evaporated films of W, a value being found in two cases, and in two others the potential difference was zero. This gave 2×10^{17}/c.c. as the lower limit of the number of free electrons in Au and 9×10^{15}/c.c. in W.
R. S. R.

594. Influence of Water Content on the Volta Effect. R. Deaglio. *Zeits. f. Phys.* 51. 3–4. *pp.* 279–286, 1928.

The damp, gaseous surface layer of moisture on metals acts as a secondary conductor. By evacuation or drying the surrounding air, the characteristics of a second class conductor can be ascribed. An alteration of the water content cannot produce a simultaneous alteration of the Volta effect to a marked degree between the two metals. The usual Volta effect between two metals in ordinary air cannot, therefore, be related to the vapour pressure or moisture content as is sometimes hypothesised in the chemical theory of the Volta effect. Full experimental details are given of the method used.
S. G. B.

595. Volta Effect. A. W. Porter. *Electrician,* 101. *pp.* 289–290, *Sept.* 14, 1928. *Abstract of paper read before the British Assoc., Glasgow, Sept.,* 1928. *Nature,* 122. *pp.* 364–365, *Sept.* 8, 1928. *Supplement.*

A discussion of the phenomena and the theory of the Volta effect. The behaviour of the electrons in metallic conduction, and the analogy of the passage of a current from one material to another to osmosis, and the phenomena occurring with solutions and semipermeable membranes are dealt with. Caution and the avoidance of dogmatism are necessary. Much more detailed experimental knowledge is required before the electric circuit is really understood. The electronic theory in metals still has its difficulties, and there are great experimental difficulties in connection with the direct measurement of the Volta effect.
J. J. S.

596. Hall Effect. W. W. Sleator. *Phys. Zeits.* 29. *pp.* 628–629, *Sept.* 1, 1928.

In connection with Sommerfeld's electron theory [see Abstract 1368 (1928)] the author gives a theoretical examination of Corbino's experiment in which he subjected a disc traversed by a radial current to the action of a magnetic field perpendicular to the disc [see Abstract 1597 (1911)]. In such a disc there is a component of current along a concentric circle whose middle point is in the middle of the disc, *i.e.*, in the direction of lines of equal potential. The total current can be measured by its inductive action. The question considered is whether with this arrangement another value for the Hall constant is obtained different from that with the usual arrangement of the right-angled plate, first making use of the classical theory and second on the basis of Fermi's statistics. The conclusion is that the equation which leads to the determination of the Hall constant in the case of the circular disc is the same as that for the right-angled plate. J. J. S.

597. Law of Wiedemann, Franz and Lorenz. Attempt to Explain the Isothermal Line. E. Grüneisen. *Zeits. f. Phys.* 51. 9–10. *pp.* 652-668, 1928.

In a previous paper Grüneisen and Goens have shown that in a purely formal manner the thermal resistance of metals can be taken as the sum of two different parts. Eucken proposes to decompose the thermal conductivity of metals into the sum of the metallic and the insulator conductivities, but the author now proposes to explain the phenomenon by assuming that there are two kinds of electronic movement in metals, one of these taking place with and the other without a transportation of heat. The electrical conductivity κ will then be equal to $\kappa_1 + \kappa_2$, the thermal conductivity λ will be proportional to $\kappa_1 T$, but independent of κ_2. The law of Wiedemann, Franz and Lorenz would hold for the electronic movement of the first kind down to low temperatures, and the Sommerfeld constant could be taken as $\lambda/\kappa_1 T$. In certain cases, however, it is necessary to assume, in addition, an "insulator conductivity." The different explanations of the "isothermal line" lead to different results in the region of superconductivity. The new hypothesis leads to zero alteration of the thermal conductivity at the point of electrical superconductivity, for it depends on the first kind of electrical conductivity, which does not alter its value when superconductivity occurs. According to the former theory of Grüneisen and Goens an alteration of the thermal conductivity would take place. Eucken's theory would lead to a large increase of the thermal conductivity at the point of superconductivity; no such effect has been observed by K. Onnes and Holst in the case of mercury.

H. N. A.

598. Direct-Current Conductivity of Insulating Oils. D. H. Black. *Phil. Mag.* 6. *pp.* 369–384, *Sept.*, 1928.

A theory is put forward to account for the absorption current in liquid dielectrics. It is assumed that contact resistances are formed at one or both electrodes by the passage of an electric current, this causing the well-known decay of current with the time the potential has been applied across the electrodes. Experimental support of the theory is given, and it seems capable of explaining in a simple manner the anomalous conductivity phenomena observed in liquid dielectrics under d.c. stresses. AUTHOR.

599. Conduction of Electricity through Very Thin Layers of Solid Dielectrics. E. Espermüller. *Arch. f. Elektrot.* 21. *pp.* 148–169, *Nov.* 1, 1928.

The films used in the experiments here described were about 2 or 3μ thick and of collodion, shellac or similar materials. A guard ring method was used in the conductivity measurements. With fields of at least

10^6 volts/cm., using a direct-current supply, a change appears to take place in the resistance of the film which may return approximately to its original value on application of alternating voltages. The conductivity observed with the films used was in all cases electrolytic in type. Full details are given of the method of producing the films and of the apparatus used in the measurements. [See also Abstract 2790 (1927).] A. W.

600. Association in Liquid Dielectrics. J. Rolinski. *Phys. Zeits.* 29. *pp.* 658–667, *Sept.* 15, 1928.

The electric polarisation is measured in binary mixtures of dipole-free liquids (benzol, CS_2, CCl_4); it is confirmed for such mixtures that the molecular polarisation is independent of the concentration and that the additive law applies to the volume-polarisation. Binary mixtures of dipolar liquids (ethyl-ether, chlorobenzol, quinoline) are examined; the molecular polarisation is not constant, but rises with the concentration, on account of association of molecules. The percentage of associated molecules is calculated on the assumption that the dipolar moment of the associated molecules vanishes; this increases with increasing concentration, and for a given concentration is greater the greater the dipolar moment. The volume polarisation in dipolar mixtures does not follow an additive law, on account of a mixed molecular association. A. D.

601. Theory of Electric Breakdown. Parts II and III. P. Böning. *Arch. f. Elektrot.* 20. *pp.* 503–506, *Sept.* 17, and 21. *pp.* 25–29, *Oct.* 22, 1928.

In a previous paper [see Abstract 2490 (1928)] the following formula was derived for the connection between breakdown voltage V and the thickness d of the material, $V = ad - bd^2$, the formula holding between certain limits. The limits are here extended, certain conclusions are drawn, and after a brief discussion of various types of electrical breakdown a new factor is introduced into the above formula to take account of the time of application of the electrical stress to the material. The formula then becomes $V = ad - b(1 - e^{ct/d})d^2$, which is shown to give results in fair agreement with some experiments on gutta-percha and good agreement with experiments on oiled paper. A. W.

602. Dipole Moments of Symmetrical Compounds and Cis-Trans-Isomerism of Simple Bonds. R. Engeland. *Phys. Zeits.* 29. *p.* 626, *Sept.* 1, 1928.

It is pointed out that the essential content of Weissberger's deductions [see Abstract 2494 (1928)] is the discussion of the question as to whether the so-called residual valency in conjunction with the principal valencies can give rise to cis-trans-isomerism, a question which, however, has been decided in unequivocal positive terms by Schlesinger's proof that certain bis-α-imino acids form two different copper salts which differ appreciably from each other in colour, solubility, etc., and are readily interconvertible. H. H. Ho.

603. Dipole Moments of Some Methane and Ethane Derivatives. J. W. Williams. *Zeits. f. phys. Chem.* 138. 1–2. *pp.* 75–84, *Oct.*, 1928.

The author has discussed relationships between the value of the dipole moment and the molecular structure of benzene derivatives in a series of previous papers [see Abstract 1703 (1928)], and the present investigation extends this work to derivatives of methane and its homologues. The dielectric constants and densities at 25° in benzene have been determined for ethylene chloride and bromide, methyl, ethyl and ethylene iodides, ethylene glycol, aceto- and propiono-nitriles, ethylene cyanide and benzonitrile. If the dipole moment be ascribed to a definite group and the rest of the molecule be regarded as non-polar, then by substitution of a definite atom or radicle in benzene, methane or hydrogen, different values are found for the dipole moments of the substituted products. For molecules of the type $a\mathrm{CH_2} . \mathrm{CH_2}a$, a process is given for the approximate calculation of the angle which the characteristic vectors for the two molecular halves make with the axis of the molecule. Consideration is given to the possibility of characterising the electrical character of different constituents in the mono- and di-substitution products of methane and its earlier homologues from the dipole moments. H. H. Ho.

604. Application of the Debye Dipole Theory to Binary Liquid Mixtures. Part II. J. W. Williams. *Phys. Zeits.* 29. *pp.* 683–688, *Sept.*, 15, 1928.

In Part I [see Abstract 1703 (1928)] the author investigated the application of Debye's modified Clausius-Mosotti law to the calculation of the electric moments of dissolved molecules from the dielectric constants and the densities of suitable binary liquid mixtures. In the present paper data are given for solutions in benzene at 25° of 33 substances selected on structural grounds. It is shown that every atom or every group substituted in the benzene nucleus is characterised by a more or less definite moment which can be regarded vectorially with a definite orientation. When two or more atoms or groups are substituted in the benzene nucleus their reciprocal effect can generally not be neglected. The structural formula of benzene in which all the carbon atoms are coplanar is considered to be the most probable, and it was not found possible to represent the structure of diphenyl and its derivatives by a simple spatial arrangement. The electrical moments of some typical inorganic molecules have been determined by means of the general method now developed. It is shown that apparently no simple relationship exists between the structure of the dissolved molecule and that of the crystal. H. H. Ho.

605. Dielectric Constants of Binary Mixtures. J. W. Williams and A. Weissberger. *Am. Chem. Soc., J.* 50. *pp.* 2332–2336, *Sept.*, 1928.

Dielectric constant and density data at 25° were found for benzene solutions of *p*-phenylenediamine, 4, 4′-dichlorodiphenyl, 4, 4′-dinitrodiphenyl, 4, 4′-diethoxydiphenyl and 4, 4′-diaminodiphenyl. The electric moments of the various solute molecules which were calculated from these data confirm the statements made by Kuhn and by Adkins with regard to the structure of certain derivatives of diphenyl. In the case of the dinitro and dihydroxyl derivatives the rings of the nucleus are extended. In the case of the amino derivative the rings cannot be extended. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

606. Punctiform Records of Alternating-Current Curves. F. Eisner. *Arch. f. Elektrot.* 20. *pp.* 473–502, *Sept.* 17, 1928.

All punctiform records depend upon methods in which the charging of a condenser is used. General considerations concerning these records furnished the connection between the magnitudes involved: ratio of the time of charging the condenser τ to the period P; $\tau/P = 1/m$, m being the number of the points which can be recorded per period, or $1/m$ the velocity of the curve record. Investigation yielded the experimental result that up to 8000 Hertz a punctiform curve record is possible without too great difficulties. The method described made use of three-electrode tubes and a phase commutator. With each punctiform method the recording tension must remain constant long enough for a period to be registered. This time was found to be independent of the recording frequency. It is assumed that any given period of high frequency can be registered in $1/a$ sec. Using a moving strip for registration, the amplitude of the high frequency should change with such velocity that it can be considered as constant during $1/a$ sec., and the period of the change must be m times as great as $1/a$ sec. Accordingly thoroughly modulated high frequency can be recorded, only the modulation frequency should not exceed a/m Hertz. J. J. S.

607. Coils with High-Frequency Currents. R. Rücklin. *Arch. f. Elektrot.* 20. *pp.* 507–532, *Sept.* 17, 1928.

An account is given of an experimental research on the problem of the current and potential distribution in cylindrical coils with high frequency. The theory is also discussed and the results compared with those of other investigators. When in a coil (cylindrical or flat) fed by alternating current the frequency is increased a region of critical frequency is attained in which the distribution of the spatial current and tension changes gradually from a periodic into a steadily rising state. The "critical frequency" $a_k = w/\sqrt{l\gamma}$ lies in the cases examined within this region. Here w = length of winding, l = inductivity per unit length of winding measured along the wire, γ = mutual inductivity divided by length of winding. The phase velocity along the winding may be calculated for lower frequencies with good approximation according to the formula $v = 1/\sqrt{lc}$, where c is the capacity per unit length of winding. Above the fundamental frequency the coils behave as a conductor with distributed capacity and inductance; with higher frequencies the connection is very complicated, and with the highest frequencies the notions capacity and inductivity in general no more exist. J. J. S.

608. Distribution of Heat Emission in the Magnetic Hysteresis Cycle. F. W. Constant. *Phys. Rev.* 32. *pp.* 486–493, *Sept.*, 1928.

Warburg has shown that for a complete magnetic hysteresis cycle an amount of energy equal to the area of the I-*vs* H loop is dissipated and appears as heat. But for a part of a cycle theory only states that energy $= \int H^{H+\Delta H} H dI$ is supplied to the iron. Part of this energy appears as heat, while the rest is stored as magnetic potential energy and is released in another part of the cycle. The distribution of the heat emissions for successive steps along the hysteresis cycle was obtained experimentally from the rises in temperature produced in the iron or steel. The corresponding values of $\int H dI$ were obtained from the hysteresis looop. The difference between these quantities gave the potential energy throughout the cycle. The potential energy was greatest for $H = H_{max.}$, zero for $H = O$. The heat emission was zero from $H = H_{max.}$ to $H = O$, increased up to a little beyond $H = -H_c$ (H_c is the coercive force), and then decreased to $H = -H_{max.}$. A cooling was never observed. The results are discussed in connection with a recent theory of atomic behaviour in ferromagnetic metals. **Author.**

609. Magnetic Properties of Perminvar. G. W. Elmen. *Frank. Inst., J.* 206. *pp.* 317–338, *Sept.*, 1928.

An examination of the entire range of Ni-Fe-Co alloys is recorded, and it is shown that at least one-third of the alloys in the series show some of the characteristic perminvar properties in the annealed condition. The proportions of nickel and cobalt may be varied over a wide range, but much less variation in the iron content is permissible, being less than one-half the amount of the other constituents. Iron and cobalt appear to increase the constancy of the permeability but decrease its initial values. Nickel gives high initial values but less stability, large proportions decreasing the constancy. With high nickel content, high permeability and moderate constancy make for a larger range of flux densities in which the permeability is constant and increases the range of flux densities with low hysteresis loss. Experiments conducted on alloys baked at 425° C. for some time indicated the inclusion of a number of other alloys of the series not included in the perminvar range under ordinary conditions. The results are incorporated in tables and curves. The unusual magnetic properties acquired by certain alloys on heat treatment is also investigated. Slow cooling through a narrow temperature range, or continuous heating for a long period at the lower end of the range, resulted in perminvar characteristics in the alloy, whilst rapid cooling produced no such properties. The phenomena are explained by the changes in the constitutional composition of the alloy, which at high temperatures is a homogeneous solid solution, but on cooling, as saturation is accomplished, the alloy segregates into a mixture of two solid solutions of different concentrations. This was tested by investigations on a perminvar core and a bimetallic rod. The electrical resistance is also affected by slow cooling. After baking an air-quenched alloy (Ni 45 %, Co 25 %, Fe 30 %) at 425° C. the resistance had decreased by 10 %. It is suggested that the low hysteresis loss at low flux densities of perminvar may be due to the segregation of one of the constituents as a material of much lower hysteresis than any previously known material. The consequences of these properties to the engineer are discussed. S. G. B.

610. Magnetic Field Intensity at Any Point in the Plane of a Circular Loop. A. P. Strom. *Frank. Inst., J.* 206. *pp.* 339–344, *Sept.*, 1928.

In this paper a method is developed for calculating the magnetic field intensity at any point in a circular loop in which an electric current flows. The method is based upon Ampere's equation, $H = I \,.\, dl \,.\, \sin\alpha/\rho^2$. The general case when the point at which the intensity is desired is not at the centre is treated, and the equation reached is

$$H_a = \frac{Ir}{r^2 - a^2} \,.\, 4E,$$

which gives the field intensity at any radius a cm. from the centre of a circular loop carrying a current I abamperes. E is an elliptic integral whose value for any particular value of a/r may be found from a table of elliptic integrals. J. J. S.

611. Attempt to Detect a Magnetic Field as the Result of the Rotation of a Copper Sphere at High Speed. W. F. G. Swann and A. Longacre. *Frank. Inst., J.* 206. *pp.* 421–434, *Oct.*, 1928.

An account of an experiment where a copper sphere was rotated at 200 revolutions per second in a space compensated for all other possible factors influencing the production of magnetism. The work found its origin in an attempt to explain the production of the earth's magnetic field. Two theories are put forward, namely, that the field would be proportional to $D\omega r$, or $Dr^3\omega^4$. It is ultimately shown that the present experiments, in agreement with those of Lebedew, failed to detect any magnetic field due to the rotation alone of a neutral body. S. G. B.

612. Relation between Size of Crystal and Magnetic Properties in Pure Iron. G. J. Sizoo. *Zeits. f. Phys.* 51. 7–8. *pp.* 557–564, 1928.

The magnetic properties of electrolytic iron fused in a vacuum have been investigated. The effect of crystal size is small, and may be easily obscured by differences in mechanical or thermal treatment. The wires or strips under test were, therefore, treated with this in view. With increase in size of the crystal, coercive force and hysteresis loss diminish, but the maximum permeability increases. Remanence, electric resistance and its temperature coefficient are all unaffected by the size of the crystal. The conclusions are in agreement with Weiss's theory of the spontaneous magnetisation of crystals. G. E. A.

613. Magnetic Properties of Evaporated Films of Nickel. K. J. Miller. *Phys. Rev.* 32. *pp.* 689–690, *Oct.*, 1928.

Films of nickel produced by evaporation on aluminium foil were tested in fields up to 167 gauss. The coercive force reached a value approximately three times that for hard drawn wire and retentivity was observed as high as 65 %. The coercive force decreased with decreasing deposit temperature and increasing thickness. No critical thickness was observed. The films were of uniform thickness, and were uninfluenced in their properties by distortion after deposit. AUTHOR.

614. Magneto-Resistance Effect in Single Crystals of Nickel. S. Kaya. *Tohoku Univ., Sci. Reports,* 17. *pp.* 1027–1037, *Sept.*, 1928. *In English. Report No.* 202 *from the Research Inst. for Iron, Steel and other Metals.*

The change in the electric resistance of single crystals of nickel when placed in a magnetic field parallel or perpendicular to the direction of the current has been measured with a potentiometer. The specimens used were rods of rectangular cross-section, the axes of which coincide respectively with the tetragonal, digonal and trigonal axes. In the case of the longitudinal effect, every direction of the axes shows increases of resistance, the amounts of which are in the decreasing order of [111], [110] and [100]. In the case of the transverse effect, both increase and decrease of resistance are observable according to the directions of the magnetic field. AUTHOR.

615. Magnetic Properties of Some Substances in the Adsorbed State. S. S. Bhatnagar, K. N. Mathur and P. L. Kapur. *Indian Journ. Phys.* 3. *pp.* 53–66, *Sept.* 30, 1928.

Recent work favours the view that adsorption is a chemical process, but many substances are still believed to retain their physico-chemical properties in the adsorbed state. The susceptibility of $FeCl_3$ was measured when adsorbed by coconut charcoal, and the substance (mass susceptibility $+ 92 \cdot 10^{-6}$) was found to have become markedly diamagnetic, an effect which could not be ascribed to a preponderance of adsorbed Cl ions. $NiCl_3$, $CoCl_3$ and $MnCl_2$ were also tested, and in all cases the magnetic character of the adsorbed ion was profoundly affected. The experiments confirm the view that some chemical change takes place between the adsorbent and the adsorbed material. [See also Abstract 344 (1925).]

G. E. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

616. The Heart Beat Considered as a Relaxation Oscillation, and an Electrical Model of the Heart. B. van der Pol and M. J. van der Mark. *Onde Élec.* 7. *pp.* 365–392, *Sept.*, 1928. *Phil. Mag.* 6. *pp.* 763–775, *Nov.*, 1928.

The theory of the production of electrical oscillations in undamped, damped and retroactive circuits is discussed. If in the well-known equation $\ddot{v} + \alpha\dot{v} + \omega^2 v = 0$ we have $\alpha^2 << \omega^2$, then we have a sine-wave form of discharge of the type $\omega^2 = \frac{1}{CL}$ (with the usual nomenclature). If the condition $\alpha^2 << \omega^2$ is replaced by $\alpha^2 >> \omega^2$ an aperiodic discontinuous discharge is obtained. Such types of discharge are termed " relaxation oscillations." Illustrations of this type of discharge are given, for example, the Wehnelt interrupter in electricity, the variation of animal species, menstruation and the cardiac cycle in physiology. The properties of such relaxation oscillations are then considered and an electrical system with three degrees of freedom is developed. A model is illustrated built up of appropriate resistances, capacities, inductances and neon-tube indicators. This electrical model represents the heart, the respective circuits being equivalent to the sinus, the auricle and the ventricle, the bundle of His being represented by the coupling between circuits. This model is used to illustrate well-known pathological cardiac conditions, for example, heart block and various types of entra-systole. It is found there is analogy between the oscillographs of this electrical system and the actual electrocardiographs obtained from the actual heart. Special conditions of the electrical circuits of the model are then utilised to predict pathological conditions of the heart which have apparently not yet been described in pathology. This paper, which considers the heart from a purely physical aspect, is of very considerable interest, and infers that further progress in cardiology may be obtained from such physical considerations.

B. J. L.

617. New Application of High-Frequency Currents in Medical d'Arsonvalisation. Bordier. *Comptes Rendus*, 187. *pp.* 687–688, *Oct.* 15, 1928.

The author has designed a special electrode for the introduction of medicants into the tissues by means of high-frequency currents produced either by circuits containing inductance and a spark gap (Oudin) or by means of triode valve circuits. The absorption of the medicant is not due to electrolysis, but to vasodilation resulting in direct absorption in some cases and, in other cases, due to bombardment of the skin surface by particles of the medicant in the electric field due to the " effluve."

B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

618. Reversal of Traube's Rule of Adsorption. H. N. Holmes and J. B. McKelvey. *J. Phys. Chem.* 32. *pp.* 1522–1523, *Oct.*, 1928.

Freundlich pointed out repeatedly that while surface-tension lowering may be great in aqueous solution, it should be very much less in organic liquids which themselves have a very low surface tension. Consequently adsorption should also be slight in amount. Patrick and Jones [see Abstract 1224 (1925)], however, observed notable adsorption from benzene, toluene, nitrobenzene, etc.; and since Freundlich dealt with carbon, a non-polar solid, and water, a polar liquid, the authors have now found a reversal in the order of adsorption in a homologous series of fatty acids when these are adsorbed on silica, a polar solid, from toluene, a non-polar liquid. H. H. Ho.

619. Adsorption of Gases by Graphitic Carbon. Part II. H. H. Lowry and R. M. Bozorth. *J. Phys. Chem.* 32. *pp.* 1524–1527, *Oct.*, 1928.

Previous data by Lowry and Morgan [see Abstract 393 (1926)] seem to disagree with the results of Ruff and collaborators (*Zeits. f. anorg. Chem.* 167, 185, 1927), who concluded that amorphous carbon only possesses a noteworthy adsorptive capacity. It was pointed out previously (*loc. cit.*) that carbon prepared from graphitic acid had the same density as graphite, and this conclusion is borne out by the X-ray evidence now presented. In the X-ray photographs diffraction bands are observed, which show that the carbon prepared by the explosion of graphitic acid is graphitic in structure, and that the individual particles are flakes averaging approximately 50 atom diameters in breadth and 10 atom layers in thickness. H. H. Ho.

620. Adsorption of Gases by NaCl and Aqueous NaCl Solutions. F. Durau. *Ann. d. Physik* 87. 3. *pp.* 307–384, *Oct.* 12, 1928.

Measurements were made of the adsorption of N_2, H_2, CO_2, O_2, and NO by purified NaCl, first non-heated, then heated. The measurements were extended to CH_4, C_2H_6, C_3H_8, N_2O and SO_2. Quantitative measurements for the adsorption of H_2O vapour were found impossible. From aqueous solutions it was concluded that an aqueous solution is formed round each NaCl crystal. The surface becomes but sparsely covered with the adsorptive. With oxygen there is an irreversibility of adsorption at the surface. The dry salt is not covered with a monomolecular layer, except in the case of hydrogen, and then only a small percentage. Under pressures below 0·4 mm. there is no measurable adsorption except in the case of SO_2. The adsorption is increased by a dipolar character in the adsorptive. The presence of gases in the NaCl has no marked influence on the adsorption-isotherms. A. D.

621. Adsorption of the Alkali Metals on a Mercury-Vacuum Interface. R. S. Bradley. *Phil. Mag.* 6. *pp.* 775–779, *Nov.*, 1928. *Supplement.*

Both Schmidt [see Abstract 346 (1913)] and Oppenheimer (*Zeits. f. anorg. Chem.* 171. *p.* 98, 1928) have published values for the surface tension σ of alkali metal amalgams at low concentrations, and the publication by Bent and Hildebrand [see Abstract 973 (1928)] of the activities a_2 of the dissolved metals enables the Gibbs' surface excess Γ to be calculated. From these data it appears that at low concentrations $d\sigma/d(\log a_2)$ is constant for the amalgams of the metals sodium potassium and cæsium. Values of Γ are in agreement with compound formation in the surface-layer, roughly to the extent of $Na\text{-}Hg_6$ for sodium, rather less for potassium. Cæsium atoms alone occupy the surface of cæsium amalgams. H. H. Ho.

622. Dielectric Properties and Structure of Colloidal Hydrophiles. N. Marinesco. *Comptes Rendus*, 187. *pp.* 718–720, *Oct.* 22, 1928.

When a liquid of permanent dipoles is solidified its dielectric constant falls abruptly, and this is explained by the forced orientation of the dipoles which can no longer follow inversions of the external field. Solution of an electrolyte in water produces the same effect, since the ions condense and fix a large number of dipoles. An identical phenomenon is now described for the case of absorption by colloidal hydrophiles, which swell and retain large amounts of water whose dipoles then have an imposed orientation. It is shown that the water fixed by a colloid may be determined by the gradient of inductive power as a function of the concentration of the sol. Experiments with data are described using methemoglobin, soluble starch and gum arabic, which illustrate the above method.
H. H. Ho.

623. Effect of One Salt on the Solubility of Another in Ethyl Alcohol Solution. Part III. F. S. Hawkins and J. R. Partington. *Faraday Soc., Trans.* 24. *pp.* 518–530, *Oct.*, 1928.

The solubilities of potassium iodide in alcoholic solutions of sodium and magnesium iodides of various concentrations have been measured. At concentrations below 0·5 *N* the solubility in sodium iodide + alcohol solutions can be represented by the equation

$$-\tfrac{1}{2}\log \text{A.P.R.} = 3a\,(\sqrt{2\mu}-\sqrt{2\mu_0})+\beta c.$$

In the case of magnesium iodide + alcohol solutions evidence for the formation in solution of the complex MgI_2, KI is given, and values of the "ionic radius" for each series of solutions are calculated. The scope of this work is to be extended to heterionic solutions. Measurements have been made of the conductivities of potassium and magnesium iodide solutions, and an equation has been found to represent the results for potassium iodide. [For Parts I and II see Abstract 3232 (1927).] AUTHORS.

624. Refraction and State of Ammonium Salts and Strong Acids in Solution. K. Fajans. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 361–382, *Oct.*, 1928.

The change of the refractive index of solutions of ammonium salts and of strong acids was examined. The dependence of the refraction on the concentration was explained on the assumption that dissociation was incomplete, and that the opposing, deforming action of the ions in direct contact influenced the refraction. The abnormal behaviour of hydrochloric acid was explained by new experimental evidence. It was shown that for solutions of the sodium salts of a series of acids—*viz.*, HI, HBr, HCl, CH_3, COOH, HNO_3, $\tfrac{1}{2}H_2SO_4$, $HClO_4$—the change of refraction with increase of concentration agreed with the sign and the relative strengths of the change of refraction of these acids which took place as the concentration passed from an infinitely dilute solution to the homogeneous undissociated acid. In this case the change is certainly due to the formation of undissociated molecules, and hence on parallel grounds the changes in the salt solutions must be due to the same cause. F. J. B.

625. Theory of Partial Osmotic Pressures and Membrane Equilibria, with Special Reference to the Application of Dalton's Law to Hæmoglobin Solutions in the Presence of Salts. G. S. Adair. *Roy. Soc., Proc.* 120. *pp.* 573–603, *Oct.* 1, 1928.

The author appends a long list of references to the literature. He also refers to his earlier work on osmotic pressures of aqueous solutions of hæmoglobin. Wide deviations are now found to occur in the measurements of the osmotic pressures of hæmoglobin and of the membrane equilibrium of diffusible salts from the theoretical formulæ of Donnan (1911) and Loeb (1922). It is shown that within certain limits of hydrogen-ion and salt concentrations, including the range that occurs in the blood, the observed osmotic pressures of hæmoglobin can be interpreted by the application of Dalton's Law of Partial Pressures in the form used by Gibbs. J. K.

626. Structure of Copper-Tin Alloys. W. Broniewski and B. Hackiewicz. *Comptes Rendus*, 187. *pp.* 651–654, *Oct.* 15, 1928.

The missing phase ϑ is Cu_3Sn_2. Equilibrium is exceedingly slowly attained, and it appears that the uncertainties which have characterised previous work have been due to imperfect annealing. A. D.

627. Influence of Composition and Hammering on the Corrosion and Increase in Number of Grains of Aluminium. L. Guillet and Ballay. *Comptes Rendus*, 187. *pp.* 585–587, *Oct.* 8, 1928.

The authors point out that the results of various investigations on the corrosion of aluminium, especially on the effects due to hammering, are very discordant. In this paper the effects of various corrosive substances, such as nitric acid, hydrochloric acid, sulphuric acid and 3 % sodium chloride solution, are investigated on different aluminium samples of varying degrees of purity before and after these have been subjected to hammering. It is also shown that the number of grains developed on recrystallisation after hammering is very much greater for pure aluminium than for the commercial varieties. J. K.

628. Cataphoresis and the Electrical Neutralisation of Colloidal Material. S. Mattson. *J. Phys. Chem.* 32. *pp.* 1532–1552, *Oct.*, 1928.

An ultramicroscopic cell which permits a rapid determination of the cataphoretic movement of colloidal particles is described with applications, *viz.*: (1) The electrical neutralisation of clay suspensions by aluminium salts, where the products of hydrolysis of these salts rather than the trivalent cations are active. (2) The electrical neutralisation of clay by the basic dye methylene blue in the presence of different anions and cations showed that the isoelectric ratio (methylene blue/clay) was increased by the former and decreased by the latter ions, the effect increasing with the valence. (3) The quantities of methylene blue required to neutralise the electronegative proteins in milk decreased with the acidity (*i.e.*, increased with the freshness) of the latter. The electrical neutralisation of the colloidal materials in raw sugar and in molasses indicated a proportionality between the neutralising power and the quantities of colloidal material present. (4) $BaSO_4$ was found to be electropositive when alone or in the presence of excess Ba, but electronegative in presence of excess SO_4. The electropositive condition causes a decrease and the electronegative an increase in the *p*H of the solution; the former is regarded as due to a difference in solution tension of two ions and the latter as due to an adsorption of the OH and H ions of the water respectively. (5) The behaviour of certain soluble electrolytes, such as sodium ferrocyanide of forming a turbid suspension before dissolving was cataphoretically investigated, and the crystal chips, which in water break away from the larger crystals, found to carry a very high electronegative charge. It is concluded that all electrolytes may give rise in water to a dissociation p.d. at the phase boundaries, the sign of the charge being determined by the solution tension and osmotic pressure of the respective ions. The cause of the electronegative charge of the great number of inert materials is to be sought in the adsorbed layer of oriented water molecules, which apparently attract the anions to the interfacial side of this layer, giving rise to an adsorption potential. Adsorbed water is held to be more acidic than free water. H. H. Ho.

629. Gaseous Combustion at High Pressures. W. A. Bone, D. T. A. Townend and G. A. Scott. *Roy. Soc., Proc.* 120. *pp.* 546–563, *Oct.* 1, 1928.

The peculiar influence of successive replacements of carbonic oxide by hydrogen on the explosion of theoretical $2(mH_2 + nCO) + O_2 + 4N_2$ mixtures observed by Bone and Haward [see Abstract 943 (1922)] appears abruptly when the hydrogen content of the mixture exceeds about 0·65 % and is a " knock " effect removable by raising the bomb temperature to 100° without altering the charge-density. If this is done, further replacement of carbonic oxide by hydrogen has a catalytic effect until about 1 % of hydrogen is present and afterwards purely additive. Successive small additions of steam to a theoretical carbonic oxide-air mixture on explosion at initial pressures of 32·2 and 64·4 atmos., with the bomb chamber at 100°, promote combustion, but the steam does not intervene chemically by undergoing continuous decomposition and regeneration. Optimum conditions are reached with about 1 % of steam. Apart from the knock effect mentioned, a small proportion of hydrogen has a greater effect than its equivalent of steam in accelerating the explosion of a carbonic oxide-air mixture at high pressures, and it seems probable that it is the catalytic effect of the hydrogen which exceeds that of the steam. The progressively increasing lag in the time required for the pressure to reach its maximum value as the initial pressure is increased is mainly a nitrogen effect, as it is not observed when the nitrogen is replaced by its equivalent of either carbonic oxide or argon. T. H. P.

630. Gaseous Combustion at High Pressures. W. A. Bone, D. M. Newitt and C. M. Smith. *Roy. Soc., Proc.* 120. *pp.* 563–572, *Oct.* 1, 1928.

Further experimental results [see Abstract 1760 (1928)] show that the mere drying of carbonic oxide-air mixtures narrows their explosion ranges at the high initial pressures employed. Thus, at 32·2 (64·4) atmos., the percentages of carbonic oxide in the limiting mixtures are 18·1 — 62·7 (18·9 — 59·3) for the dry mixtures and 15·7 — 65·7 (16·6 — 66·7) for mixtures which are 80 % saturated with moisture at 100°. With the moist mixtures increase of the pressure (charging density) results in a slight shift of the limiting percentages of carbonic oxide downwards without narrowing the explosion range, but with the dry mixture the explosion range is definitely narrowed by doubling the initial pressure. The influence of increase of temperature *per se* is to widen the explosion range of these mixtures. T. H. P.

631. Extraction of Krypton and Xenon from the Air and from Gas Dissolved in Water. G. Claude. *Comptes Rendus*, 187. *pp.* 581–585, *Oct.* 8, 1928.

A method of fractionally distilling liquid air is described. The apparatus is provided with a means of washing the vaporised oxygen in a stream of the incoming liquid oxygen, whereby a concentration of the krypton and xenon is effected. The liquid which collected at the bottom of the rectifier contained from 40 to 50 % of the krypton and xenon originally present in the air. In order to concentrate still further the rare gases the oxygen containing about 0·001 % of krypton and xenon was burnt in an atmosphere of hydrogen, whereby the content of the rare gases was raised to about 2 %. The gases were passed over silica, and concentrated further by the method described by Lepape [see Abstract 3136 (1928)]. By these means it was possible to obtain 10 to 11 litres of krypton and 0·8 to 1 litre of xenon per day. It was found that krypton and xenon are much more soluble in water than oxygen and nitrogen. It was proposed that the air dissolved in water might be used for the isolation of these rare gases. F. J. B.

632. Studies on Fluorescence and Photosensitisation in Aqueous Solution. Parts I, II and III. *Roy. Soc., Proc.* 121. *pp.* 294–298, 299–312, *and pp.* 313–317, *Nov.* 1, 1928.

Part I, by **W. West, R. H. Müller** and **E. Jette,** gives an application of the concept of " collisions of the second kind " to processes occurring in solution, especially to the extinction of fluorescence and photosensitisation, and the conditions necessary to be fulfilled for photochemical sensitisation are analysed.

Part II, by **E. Jette** and **W. West,** quantitatively examines the effects of various salts on the fluorescence of aqueous solutions of three representative fluorescent substances, quinine bisulphate, sodium salt of fluorescein and uranyl sulphate. It has been found that: (1) the extinguishing effect is associated practically entirely with the anion, silver ion being the only positive ion whose effect was noticeable; (2) the order of the extinguishing effect of the anions is

$$I' > CNS' > Br' > Cl' > Ox'' > Ac' > SO_4'' > NO_3' > F'.$$

This series is identical with the deformability series of the ions. The effects are interpreted in terms of the conception of collisions of the second kind, and the main result of the investigation is that the more deformable the electron orbits of the colliding particles, the more probable is a collision in which energy is transferred to it from particles in a higher quantum state than the normal.

Part III, by **R. H. Müller,** shows that the quantum efficiency for the photolysis of oxalic acid in the presence of uranyl ion approaches unity at a ratio $H_2C_2O_4/UO_2$ of 1 : 1, and remains constant for higher ratios. The fluorescence of uranyl ion with increasing additions of oxalic acid decreases, reaching zero at the same mole ratio. This is taken as good evidence for the similarity of this reaction to the care of excited mercury and molecular hydrogen studied in the gaseous phase by Caris and Franck. The rate of decomposition is inhibited by those ions which possess the ability to extinguish the fluorescence of uranyl ion. The order for the inhibiting effect and the extinguishing effect is the same for these ions. The same order for the inhibition of photochemical reactions sensitised by non-fluorescing ions holds for these ions. H. H. Ho.

633. Chemical Interactions corresponding to the Constant of Mass Action being a Function of the Volume and Masses of the Constituents as well as of the Temperature and Catalytic Action. Part II. R. D. Kleeman. *Phil. Mag.* 6. *pp.* 648–659, *Oct.*, 1928.

This paper continues a previous investigation [see Abstract 2857 (1928)] and is based on differential equations obtained by means of a certain isothermal cycle varied according to conditions. The effect of small dissociation on the constant of mass action of a gaseous mixture is first considered. Then follow sections devoted to the catalytic effect of a surface absorbing substance and of a bulk absorbing substance respectively on the constant of mass action. Finally, the functional nature of the constant of mass action of electrolytes is discussed, from which it appears that when an electrolyte dissociates easily into ions the constant of mass action is a function of the volume of the solution as well as of the temperature. This signifies that either the chance of a molecule dissociating into ions depends on its previous encounters with other molecules, or that the chance of two ions of opposite sign combining on collision depends on previous encounters with other ions and molecules, or that both effects occur. H. H. Ho.

634. Kinetics of the Reaction between Calcium and Nitrogen. A. v. Antropoff and E. Germann. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 209–237, *Oct.*, 1928.

The reaction between calcium and nitrogen is found to occur in the most favourable temperature range of 400°–600° C. in three stages. In the first, a rapid reaction takes place between the crystalline surface and nitrogen; in the second, a slow reaction results from the protection offered by the thin amorphous film of calcium nitride, and in the third stage, a very rapid reaction sets in when the nitride film has attained a certain thickness and apparently becomes porous through crystallisation. Traces of oxygen present in the nitrogen entirely prevent the initial reaction, but after the formation of the porous nitride film do not hinder. The oxygen, in fact, reacts with the nitride, which thereby acts as a filter in preventing access of the oxygen to the calcium surface. The presence of lithium, sodium, or potassium is found to have a marked accelerating action on the reaction between calcium and nitrogen. This activating effect is due to its causing a rapid transformation of the amorphous nitride to the crystalline porous form. The effect is distinguished from usual catalytic action in that, if after the activation the alkali metal is removed, the reaction velocity is maintained without falling. The activity of commercial calcium is considered to be due to the presence of free sodium, variations in the amount of which lead to differences in the reactivity. In the preparation of calcium for the absorption of nitrogen the most effective treatment is found to consist of coating its surface with sodium by vaporising the latter in a vacuum. J. N. P.

635. Rate of Solution of Cadmium in Hydrochloric Acid. M. Centnerszwer. *Zeits. f. phys. Chem.* 137, 1–4. *pp.* 352–360, *Oct.*, 1928.

Cadmium is one of the metals whose solution pressure is smaller than the supertension of hydrogen in diluted acids, and cadmium is, therefore, not soluble in such acid at measurable rates. The supertension of hydrogen on a cadmium electrode is 0·392 volt, but rises with increasing current density to 0·665 volt. The kinetics of the solution of cadmium resemble those of zinc [see Abstract 872 (1926)] and aluminium. The velocity of dissolution becomes measurable in hydrochloric acid of 6 *N* or more. There is an initial induction period; activated cadmium dissolves with uniform velocity. Stirring increases the rate only in highly concentrated acid (10 *N*). The chemical reaction is the primary factor, and the diffusion secondary, except at higher temperature (up to 50°) and concentration.

H. B.

636. New High-Temperature Fixation Reactions of Nitrogen. N. W. Krase and B. Mackey. *J. Phys. Chem.* 32. *pp.* 1488–1494, *Oct.*, 1928.

The fixation of nitrogen at high temperatures was discussed from a thermodynamic standpoint. The cases considered were the interaction of nitrogen, hydrogen, and carbon, forming cyanogen and hydrocyanic acid, nitrogen and methane, nitrogen and acetylene. Temperatures ranged from 289° to 3500° absolute. The reaction between nitrogen and methane to form HCN is complete at 2000° absolute. The combination of nitrogen and acetylene to form HCN is quite marked at relatively low temperatures, and should yield a gas containing 70 % HCN by volume at the temperature of the arc furnace. The reaction between nitrogen and carbon dioxide in the arc should produce a concentration of nitric oxide more than double that when air is used.

F. J. B.

637. Absolute Velocities of the Water Molecules Expelled during Dehydratation of Crystal Hydrates. Part II. A. Predwoditelew. *Zeits. f. Phys.* 51. 1–2. *pp.* 136–149, 1928.

This investigation extends previous work [see Abstract 1086 (1928)], but in another direction, and derives a method for calculating the velocities of molecules which are expelled during the disintegration of a solid substance. Examples are given of the dehydratation of oxalic acid COOH/COOH . $2H_2O$, sodium thiosulphate $Na_2S_2O_3 . 5H_2O$, and sodium borate $Na_2B_4O_7 . 10H_2O$. From the velocities so found the heats of hydratation were calculated and found to be in excellent agreement with data from thermochemical methods.

H. H. Ho.

638. Pyrochemical Daniell Cells. R. Lorenz and F. Michael. *Zeits. f. phys. Chem.* 137. 1–4. *pp.* 1–17, *Oct.*, 1928.

Potential measurements are made of cells consisting of two metals in their fused chlorides at temperatures ranging from 350° C.–750° C., and the temperature coefficients are ascertained. The combinations employed are the following: Tin/tin chloride/thallium chloride/thallium; lead/lead chloride/thallium chloride/thallium; zinc/zinc chloride/tin chloride/tin; zinc/zinc chloride/lead chloride/lead; and zinc/zinc chloride/thallium chloride/thallium. Each of these metals in its chloride is then combined with an element of magnesium in magnesium chloride, and the differences in the potentials of the successive combinations are found to be equal to the corresponding combinations in the first series.

J. N. P.

639. Potential of Photoactive Cells containing Fluorescent Electrolytes. H. W. Russell. *Phys. Rev.* 32. *pp.* 667–675, *Oct.*, 1928.

The variation with the time of illumination of the potential of a cell containing rhodamin B dissolved in absolute alcohol is investigated. A theory of the variation of the potential with the time is developed for the photoactive cell, and it is assumed that the exciting light produces a chemical change in the electrolyte. Allowing for the effects of diffusion, the expression is derived:—

$$= \mathrm{K} \log (\mathrm{T}^{1/2} - t^{1/2} + t/2\mathrm{T}^{1/2} - t^2/8\mathrm{T}^{3/2} + \mathrm{B/I}) - \mathrm{K} \log (\mathrm{B/I}),$$

where E is the e.m.f., T the time of the illumination, *t* the time after the illumination ceases, I the intensity of illumination, and K and B are constants. By the use of a cell with platinum electrodes containing rhodamin B in absolute alcohol and illuminated with monochromatic light, results in good agreement with the theory are secured. Diffusion is shown to play an important part. Goldmann's theory is shown to be inadequate. No "limiting potential" independent of the intensity of the illumination was found. No evidence was obtained which indicated the presence of the Hallwachs photoelectric effect. AUTHOR.

640. Application of the Method of Distribution Coefficients for the Determination of the Activity Coefficients of Undissociated and Dissociated Components of Salicylic Acid in Neutral Salt Solutions. B. v. Szyszkowski and A. v. Skapski. *Zeits. f. phys. Chem.* 137. *pp.* 238–262, *Oct.*, 1928.

Measurements are made of the distribution of salicylic acid between benzene and aqueous salt solutions in order to determine the influence of neutral salts on the dissociation equilibrium of salicylic acid in water. The salts employed are sodium chloride, chlorate, nitrate and sulphate, barium chloride and magnesium sulphate at concentrations from 0·005 M to 2·0 M. The activity coefficients of the undissociated and dissociated acid constituents are calculated. The solubility of salicylic acid in these salt solutions is determined, and the following general equation is derived to express the influence of neutral salts on the solubility of weak electrolytes:—

$$\frac{\overline{\mathrm{C}}}{\mathrm{C}} = \frac{1 - a}{fo} + \frac{a}{f}$$

where $\overline{\mathrm{C}}$ is the solubility in the salt solution, and C that in pure water, *a* is the degree of dissociation corresponding to the solubility value C, *fo* is the activity coefficient of the undissociated acid, and *f* that of the dissociated acid. In accordance with this formula it is found that the solubility of the weak acid in water at first increases with increasing ionic concentration, reaches a maximum value, and beyond this the solubility falls with further increase in the concentration. This relation and the influence of ionic concentration on the activity coefficients of dissociated and undissociated acid are shown graphically. The graphs of the solubility of the acid in benzene when plotted against the square root of the concentration gives a linear relation in accordance with theory. The dissociation equilibrium for different concentrations of acids in the salt solutions is, moreover, found to be constant in agreement with the Ostwald dilution law. J. N. P.

641. Corrosion and Residual Current. F. Tödt. *Zeits. f. Elektrochem.* 34. *pp.* 586–595; *Disc.*, 595, *Sept.*, 1928. *Paper read before the Deut. Bunsen Gesell., Munich, May*, 1928.

The paper is divided into two parts. The first deals with the significance of the residual current in cases of metal corrosion. The second part deals with the residual current and metal deposition. The method of investigation adopted was the examination of the behaviour of cells of zinc, platinum, copper, cadmium, and lead. The cells were made of pairs of these metals, the electrolyte was 1/10 normal hydrochloric acid, and in a further trial 1/10 normal standard acetate solution. The current densities employed ranged from $1 \cdot 5 \times 10^{-4}$, to 120×10^{-4} ampere. The results of the corrosion experiments showed that when two different metals, dipping into a solution which is in contact with air, and the two electrodes are connected by a conductor, then the combination showed the residual current. The magnitude of the current is defined by the quantity of oxygen on the surface of the electrode which was made of the more noble metal. The residual current due to the oxygen is the important factor in corrosion, and not the overvoltage as previously considered. Similar results were obtained for the deposition of metals. F. J. B.

642. High-Voltage Arcing and Alternating-Current Electrolysis. J. W. Shipley and C. F. Goodeve. *Roy. Soc. Canada, Trans.* 22. *Sect.* 3. *pp.* 87–102, *Jan.*, 1928.

The rate of decomposition of a boiling alkaline solution by the passage of a current between steel wire electrodes under voltages from 110 to 2100 volts was determined over a wide range of currents in which arcing is produced on the electrodes. The rate of decomposition by high-voltage arcing was found to be independent of Faraday's law and the law of a.c. electrolysis, but was found to be determined by the rate of consumption of electrical energy. Arcing in a system at atmospheric pressure and at voltages up to 2200 volts was found to be completely suppressed by the application of external pressure. The evidence obtained pointed to the conclusion that the decompositions are mainly due to the high temperatures produced in the arc. Practical applications are suggested. F. J. B.

643. Decompositions of Acetyl Peroxide and Kolbe's Electrosynthesis. O. J. Walker. *Chem. Soc., J. pp.* 2040–2045, *Aug.*, 1928.

According to Schall, 1896, acid peroxides are formed as intermediate products at the anode during the electrolysis of fatty acids. Fichter extended this peroxide theory to electrochemical oxidation in general. Kolbe's reaction requires the presence of $CH_3 . CO . O$ radicles at some stage. They might result from the discharge of acetyl anions and unite to form acetyl peroxide, which would then decompose into carbon dioxide and ethane. The author finds that there is no necessity of assuming that acetyl peroxide is formed during the electrolysis of acetates. He decomposes pure acetyl peroxide, solid or in aqueous solution, by slow heating; rapid heating would cause explosion. There is no indication of a reaction $(CH_3 . CO . O)_2 = C_2H_6 + 2CO_2$, and no reason therefore to suppose that in the electrolysis of acetates, when the gases evolved at the anode are essentially carbon dioxide and ethane, acetyl peroxide had been formed at the anode. Methane is always present in the gases of the thermal decomposition of the peroxide, often in considerable amounts, but is not observed during the electrolysis of acetates. Although peroxides are stable at low temperatures, they have not yet been isolated by electrochemical means. On exposure to ultra-violet radiations in a water-cooled quartz tube the acetyl peroxide did not simply break up into ethane and carbon dioxide. H. B.

644. Electrolytic Reduction of Ortho- and Para-Oxybenzaldehydes. G. Shima. *Kyoto Coll. Sci., Mem.* 11. *pp.* 407–418, *Sept.*, 1928. *In English.*

The results of previous investigators are reviewed. The present worker found that favourable results can only be obtained in the absence of strong mineral acid or free alkali. As katholyte is employed a solution of sodium bicarbonate through which a stream of carbon dioxide is passed during the electrolytic process or a solution of sodium acetate acidified with acetic acid. It is found that the current efficiency is highest with mercury and decreases with decrease of over-voltage in the order of zinc, lead, copper, and nickel under suitable conditions. With salicylaldehyde a 94 % yield of saligenin is obtained and para-oxybenzaldehyde gives a 92 % yield of *p*-oxybenzyl alcohol. J. K.

645. Electrolytic Reduction of Vanillin and Piperonal. G. Shima. *Kyoto Coll. Sci., Mem.* 11. *pp.* 419–427, *Sept.*, 1928. *In English.*

Electrolytic reduction of vanillin and piperonal in nearly neutral solutions, though substances easily convertible to resins, nevertheless is able to give approximately theoretical yields of vanillic alcohol and piperonyl alcohol respectively. In the reduction of vanillin, a 10 % sodium acetate solution is used as katholyte in which 5 gm. of vanillin per 100 c.c. of water are suspended. Mercury is used as the kathode, and the anode is a platinum plate immersed in an anolyte of saturated sodium carbonate solution. The electrolytic reduction of piperonal is carried out with mercury as the kathode in a sodium bicarbonate solution. J. K.

646. Electrolytic Behaviour of Thin Films. Part I. Hydrogen. Part II. The Areas of Catalytically Active Surfaces. F. P. Bowden and E. K. Rideal. *Roy. Soc., Proc.* 120. *pp.* 59–89, *Aug.* 1., 1928.

Part I.—The electrode potential developed at a metal kathode by the electrodeposition of minute quantities of hydrogen is a linear function of the surface-concentration of the hydrogen and is independent of the nature of the metal; apparent variations are attributed to differences in the real areas of the kathode and can be used to measure the accessible area of the metal surface. The amounts of hydrogen are very minute, since 1/3000 of a monatomic layer produces a change of 100 millivolts in the electrode potential.

Part II.—In order to determine the accessible area of kathode surfaces, comparison is made with a surface of mercury which has an accessible area equal to its apparent area. That of a sand-papered metal is about 10 times as great, and in the case of nickel can be increased five-fold by alternate oxidation and reduction. In the case of a spongy metal such as platinum black the ratio may exceed 2000. T. M. L.

647. Calculation of Theoretical Potentials from Thermal Data. P. Drossbach. *Zeits. f. Elektrochem.* 34. *pp.* 715–716, *Oct.*, 1928.

The author replies to the criticism of G. Devoto [see Abstract 3142

(1928)] on the calculation of the theoretical potential of sodium, potassium, and calcium [see Abstract 2005 (1928)] by giving the thermodynamic grounds of the calculation. **Devoto** replied to the explanation. F. J. B.

648. Activity Coefficients and Mass-Action Law in Electrolytes. L. Onsager. *J. Phys. Chem.* 32. *pp.* 1461–1466, *Oct.*, 1928.

It was shown by F. G. Soper in a previous paper [see Abstract 1084 (1928)] that in considering the chemical interaction of dilute solutions of electrolytes, the activity coefficients obtained by his derivation were only 2/3 the value of log *f* obtained by Debye and Hückel. The consideration of the methods leading to the limiting formulæ for the activity coefficients of electrolytes employed by Soper were shown to be erroneous in those cases where his values deviate from those of Debye and Hückel. F. J. B.

649. Hydrolysis of Solutions of Zinc Sulphate and the Presence of Monovalent Zinc Ions. H. G. Denham and N. A. Marris. *Faraday Soc., Trans.* 24. *pp.* 510–515, *Oct.*, 1928.

In contradistinction to the hydrogen electrode, the quinhydrone electrode has been found to give a perfectly steady value for the hydrolysis of zinc sulphate solutions. The apparent irregular variations in the hydrolysis of such solutions as recorded by the hydrogen electrode are attributed to the action of the hydrogen in reducing the zinc ion to a lower state of valence. The hydrolysis of solutions of zinc sulphate has been determined by means of the quinhydrone electrode. AUTHORS.

650. Hydrolysis of Certain Easily Reducible Metallic Salts. H. G. Denham and N. A. Marris. *Faraday Soc., Trans.* 24. *pp.* 515–518, *Oct.*, 1928.

The quinhydrone electrode has been used for the determination of the hydrolysis of solutions of cadmium sulphate lead chloride, and nitrate and thallous sulphate. In all cases the electrode proved eminently suitable for the determination of the *p*H values of these salts, previously shown to be easily reducible by the hydrogen electrode. AUTHORS.

651. Preparation of Potassium Ferricyanide without a Diaphragm, and especially with an Alternating Current Superimposed upon a Direct Current. H. Paweck and P. Hirsch. *Zeits. f. Elektrochem.* 34. *pp.* 684–696, *Oct.*, 1928.

The workers compare the various results obtained by them in attempting to apply several means for the elimination of kathodic reduction. They find that there is no need for a diaphragm to be interposed between the kathode and the anode. Kathodic reduction can be prevented to a large extent by the use of such coverings on the kathode as potassium chromate, calcium hydroxide with or without the use of wheat starch or gelatine and gum arabic, basic copper carbonate, etc. A similar success is also attained by the superposition of an alternating current upon a direct current. The relationship between the direct current and the alternating current is found to be based on the periodicity, on the kathodic material and the kathodic current density on the current field. J. K.